

Climate-Resilient Livelihoods and Natural Resource Management for Tribal Communities in Malkangiri, Odisha: A Block-Wise Statistical Review and Development Framework

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Abstract

Malkangiri, the southernmost district of Odisha, combines a hot, sub-humid tropical climate, forested uplands of the Eastern Ghats, a majority Scheduled Tribe population (57.8%), and some of the state's largest development deficits. Livelihoods depend on rain-fed farming, forests, common water resources and wage labour, all of which are sensitive to climate variability. This paper consolidates a review. It sets out a verified statistical baseline from Census 2011, India Meteorological Department (IMD) normals and district publications; links tribal communities to natural resources at tehsil and Community Development (CD) block level; reviews recent peer-reviewed evidence on climate trends, millets, forest rights, non-timber forest products (NTFPs), watershed development and the vulnerability of Particularly Vulnerable Tribal Groups (PVTGs); records the 2026 government status and prospects of the district; and proposes an eight-pillar, block-wise framework with a phased roadmap and monitoring plan. Four findings stand out. The IMD district normal (1,514.5 mm, 84% in June–September) differs by up to 600 mm from other published normals. Heavy-rainfall events in Malkangiri have increased significantly in recent decades (Mohanty & Sahu, 2026). Literacy falls as the tribal share of a tehsil rises ($r = -0.78$, $n = 7$). Block-wise tribal counts from a secondary atlas do not reconcile with the Census total and remain indicative. Resilience will depend less on any single technology than on secure forest and land rights, diversified incomes, community institutions, climate information, and convergence of public schemes.

Keywords: Malkangiri; tribal livelihoods; climate resilience; natural resource management; Forest Rights Act; millets; NTFP; block-wise planning;

1. Introduction

Climate change multiplies existing risks for communities whose livelihoods rely directly on ecosystems. The IPCC's Working Group II assessment finds that vulnerability is highest where poverty, weak governance and dependence on climate-sensitive livelihoods coincide, and that Indigenous and local knowledge can support adaptation when rights and institutions allow it (Pörtner et al., 2022). Vulnerability combines exposure, sensitivity and the capacity to adapt (Adger, 2006), and resilience depends on the ability of social-ecological systems to absorb change and reorganise (Folke, 2006).

India's tribal districts fit this profile closely. The sustainable-livelihoods approach also emphasises the interaction of capabilities, assets and activities (Chambers & Conway, 1992; Scoones, 1998).

Odisha's climate attention has focused on the coast. Interior tribal districts such as Malkangiri face a different mix: erratic monsoons, dry spells, heat, erosion on slopes, forest degradation and remoteness. Recent work on Odisha's PVTGs reports that climate stress is reducing farm output and forest produce and pushing households towards wage labour (Badu et al., 2026). District-level vulnerability mapping shows large spatial differences within Odisha, which supports local-scale planning (Behera & Jain, 2024).

The objectives of this paper are to:

1. describe the climatic, ecological and socio-economic setting of Malkangiri;
2. build a statistical baseline and show where published figures disagree;
3. link tribal communities and natural resources at tehsil and CD-block level;
4. review recent evidence on adaptation and livelihood options;
5. record the 2026 government status and prospects of the district; and
6. propose a block-wise operational framework, roadmap and monitoring plan.

Note on terminology: the phrase “resilient climate change climax” in the original request is read as “climate-resilient adaptation outcomes”, meaning the state in which communities and ecosystems can absorb, adapt to and recover from climate stress.

2. Methods and Evidence Discipline

This is a narrative, thematic review. It merges five earlier drafts: a district review, a statistical and block-wise extension, a holistic development framework, a block-wise analysis and the previous Word version. Duplicated text was removed, conflicting figures were reconciled, and recent journal literature was added.

Sources. Official data come from the Census of India 2011 (Directorate of Census Operations, Odisha, 2014), India Meteorological Department district normals (India Meteorological Department, Regional Meteorological Centre, Bhubaneswar, n.d.), the Central Ground Water Board district profile (Central Ground Water Board, n.d.), the ICAR agro-contingency plan, the KBK Development Authority block list (KBK Development Authority, n.d.), and the district website. Recent journal articles (2019–2026) were identified through targeted searches in October 2026 and checked against the publishers' records for authors, year, volume and DOI. This is not a systematic review, and district-specific peer-reviewed work on Malkangiri is thin; evidence from comparable southern Odisha districts is flagged as analogical.

Evidence classes. Every number in this paper belongs to one of four classes: (A) official statistics; (B) secondary compilations, such as the block-wise tribal atlas counts; (C) values computed by the author from class A or B data; and (D) reported plans and news items. Class B and D items are marked in the text.

Reconciliations made in this paper.

- Annual rainfall: the IMD district normal (1,514.5 mm) is adopted as the planning baseline; six other published figures are shown for comparison (Section 4.3).
- Forest: three published estimates (24.7%, 39.9% and 58.0% of district area) reflect different definitions and years and are not interchangeable (Section 4.3).
- Block-wise Scheduled Tribe (ST) counts: the seven block figures sum to 355,549, against the Census district total of 354,614 (a difference of 935, or 0.26%); they are indicative only (Section 6.2).

- Population: the 2011 Census count is the last verified figure; the 2026 values are projections.

3. Study Area

Location. Malkangiri lies in the south-western corner of Odisha and covers 5,791 km². It borders Chhattisgarh, Telangana and Andhra Pradesh and the Koraput district. The terrain moves from the Eastern Ghats uplands to the Godavari basin, with the Sileru, Sabari and Poteru rivers and the Balimela reservoir. The reservoir isolated the northern “cut-off area”, now called Swabhimana Anchal, which was once reachable only by boat.

Climate. The climate is tropical, hot and sub-humid. Summers (March–June) often exceed 40 °C, winters are mild and dry, and rainfall is concentrated in the south-west monsoon (Section 4.3). Soils range from shallow, erosion-prone red and lateritic upland soils to alluvial and black-brown soils in valleys.

Forests. Tropical moist and dry deciduous forest with sal, bamboo and a rich understorey of food and medicinal plants supports subsistence and cash income. Forest estimates differ by source (Section 4.3).

People. The 2011 population was 613,192, of whom 57.8% were Scheduled Tribes. The Koya are the largest group, at about 147,000 (Scheduled Castes & Scheduled Tribes Research and Training Institute [SCSTRTI], n.d.). Other groups include the Bhumia, Paroja, Gadaba, Kondh and Dhruva, and the PVTGs Bonda and Didayi. Left-wing extremism constrained services for decades; the district was declared free of active Maoist presence in 2026 (Section 9).

4. Statistical Baseline

4.1 Population and social composition

Population grew from 422,300 in 1991 to 504,198 in 2001 and 613,192 in 2011 (Table 1, Figure 1a). Growth accelerated, from 19.4% to 21.6% per decade, and the compound rate over 1991–2011 was 1.88% a year, implying a doubling time of about 37 years. Extending that rate gives about 0.81 million for 2026, while IndiaStat’s district projection is 747,782; the gap of about 63,000 shows how sensitive such figures are, and both should give way to the next census (class C and B). Scheduled Tribes number 354,614 (57.83%), Scheduled Castes 138,295 (22.55%) and all others 120,283 (19.62%). About 91.9% of residents are rural.

Table 1. Population growth, Malkangiri, 1991–2011 (computed from Census counts)

Census year	Population	Decadal growth (%)	Compound annual growth (%)
1991	422,300	–	–
2001	504,198	19.39	1.79
2011	613,192	21.62	1.98
1991–2011	–	45.20	1.88

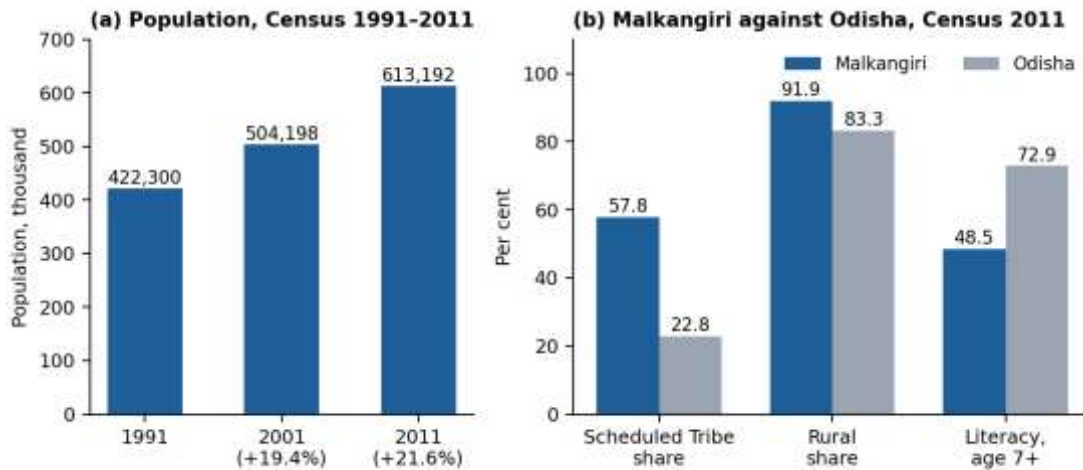


Figure 1. (a) Population, 1991–2011; (b) Malkangiri compared with Odisha, Census 2011. Sources: Census of India 2011; Odisha rural share as cited in the supplied drafts.

4.2 Literacy

District literacy in 2011 was 48.54%, which is 24.3 percentage points below Odisha's 72.87% (Figure 1b). Female literacy (38.28%) is 20.8 points below male literacy (59.07%). A 2023–24 sample-survey estimate (PLFS, age 7 and above) gives 47.34% overall and 35.79% for women, a gender gap of 23.6 points. The two sources use different methods, so they do not show a trend, but they give no sign that the gap has closed. Some publications quote 49.49% for 2011, so the Census figure should be checked against the District Census Handbook.

4.3 Rainfall and forest: where published figures disagree

Seven published annual rainfall normals range from 1,097 to about 1,700 mm, with a mean of 1,470 mm, a standard deviation of 205 mm and a coefficient of variation of 13.9% (Figure 2a). The IMD district normal is 1,514.5 mm, built from monthly normals (IMD Bhubaneswar, n.d.). Reported actual rainfall for 2024–25 was 2,206 mm, which is 46% above the IMD normal. One wet year does not establish a trend. The KBK fact-sheet value (1,096.9 mm) is reported in the supplied drafts and was not independently checked.

The IMD normals also show a sharply peaked year. Monsoon rainfall (June–September) is 1,272.7 mm, or 84.0% of the annual total; July and August alone provide 54.9%, against 48.8% for Odisha as a whole (Figure 3). Winter rainfall (6.2 mm) is the lowest of Odisha's 30 districts, and January (2.1 mm) is also the driest January. Water for crops, livestock and people is therefore short for much of the year even though the annual total is not low. The CGWB profile gives a long-term spatial range of about 994 mm in the south-west to 1,810 mm in the north-east.

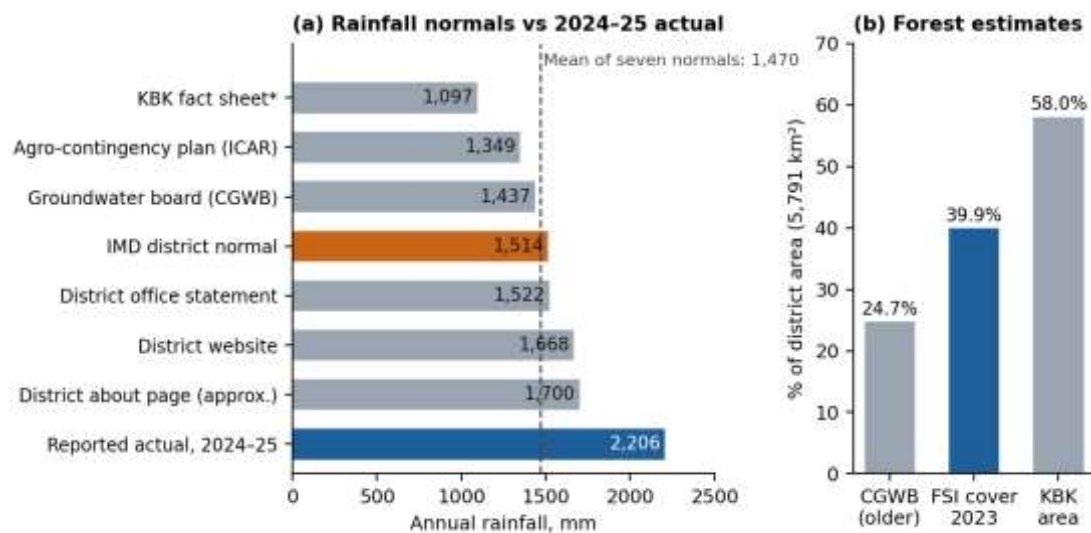


Figure 2. (a) Published annual rainfall normals for Malkangiri against reported 2024–25 rainfall (orange: IMD normal, adopted as baseline; *KBK value as cited in supplied drafts). (b) Forest estimates by definition. Sources: IMD Bhubaneswar; CGWB; ICAR; KBK Development Authority; IndiaStat; district office.

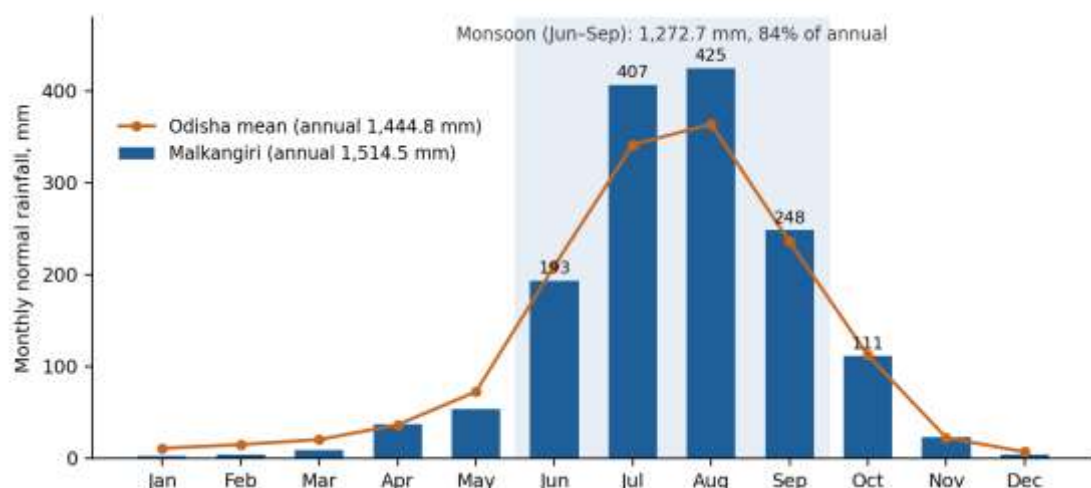


Figure 3. Monthly normal rainfall, Malkangiri and the Odisha mean. Source: IMD Bhubaneswar district-wise monthly normals; annual totals summed from monthly values.

Forest estimates range from 24.7% (1,430 km² legal forest area in an older CGWB profile) through 39.9% (Forest Survey of India cover, 2023) to 58.0% (3,355.88 km² forest area in the KBK fact sheet; Figure 2b). These measure different things. Forest cover (canopy) should be used for ecological assessment and recorded forest area for legal and rights planning; the year and definition should be confirmed with the Forest Department. The 2023 forest-cover assessment is reported by the Forest Survey of India (2024).

4.4 What the trend literature says

No station-level series for Malkangiri was available for this paper, so no new trend test is reported. Published studies give partial evidence. Using 1991–2022 rainfall data and IMD temperature data, Mohanty and Sahu (2026) found a significant increase in the frequency of heavy rainfall events in Koraput and Malkangiri, and no comparable increase in most other districts. In the neighbouring

Kalahandi, Bolangir and Koraput districts, 1980–2017 data showed a statistically significant rise in annual maximum temperature (Sen’s slope 0.29) and an increasing June–September rainfall trend (Panda & Sahu, 2019). Malkangiri was not among the districts in the second study, so its result is analogical. Together these point to a district with more intense rainfall events, longer dry seasons in between, and rising heat.

Table 2. Tests to run once station or gridded series are assembled

Question	Method	Data needed
Is annual or June–September rainfall trending?	Mann–Kendall test with Sen’s slope	IMD gridded daily rainfall, 1951–2025, district and block means
Are dry spells and droughts more frequent?	SPI-3 and SPI-6; consecutive dry days; trend in months with $SPI \leq -1$	Same rainfall series
Is heat increasing?	Mann–Kendall on annual maximum temperature and days $\geq 40^\circ\text{C}$	IMD gridded temperature, 1951–2025
Does rainfall explain millet and paddy yield?	Regression of detrended yield on seasonal rainfall and dry-spell days	Block-level crop-cutting data, 15 or more seasons
Which households are most vulnerable?	Exposure–sensitivity–adaptive-capacity index with principal-component weights and sensitivity tests; livelihood vulnerability index as used for Odisha farmers (Naik et al., 2024)	Stratified household survey, about 385 households for $\pm 5\%$ at 95% confidence, with block and PVTG strata
Do interventions raise income?	Difference-in-differences with matched villages	Baseline and follow-up household data

5. Climate Risks and Vulnerability

Table 3. Sector-wise climate stressors and likely impacts

Sector	Key climate stressors	Likely impacts on tribal livelihoods
Rain-fed agriculture	Delayed onset, dry spells, intense rain, heat at flowering	Yield instability, crop failure on uplands, soil and seed loss, food insecurity
Forests and NTFPs	Heat, shifted flowering, fire, pests, degradation	Lower NTFP yield and quality, changed collection calendars, loss of medicinal species
Water	Long dry season, runoff, siltation, patchy hard-rock groundwater	Drinking-water scarcity, drying springs, limited irrigation
Livestock	Heat stress, fodder and water scarcity, vector-borne disease	Lower productivity, mortality, distress sales

Sector	Key climate stressors	Likely impacts on tribal livelihoods
Fisheries	Reservoir level and temperature change, erratic inflows	Variable catch, access conflicts
Health	Heat stress, malaria and other vector- and water-borne disease	Illness, lost workdays, health spending
Access	Heavy rain, flash floods, reservoir fluctuation	Isolated hamlets, disrupted markets and services

Sensitivity is high because livelihoods depend on rain and forests. Adaptive capacity is low because of small upland holdings, low literacy, limited credit and insurance, weak extension and poor market access. Women carry the burden of water, fuel and NTFP collection yet have less access to titles, information and training. PVTGs are the most exposed: reports from Bonda villages describe loss of forest produce, water scarcity and youth migration for work, and across Odisha's PVTGs climate stress is shifting households from farm and forest work towards wage labour, which also threatens traditional knowledge and cultural identity (Badu et al., 2026). The authors' work is at the version-1 stage of F1000Research and has not yet been peer reviewed, so these findings should be read as indicative. The wider health status of PVTGs in Odisha has been reviewed by Bhoi and Acharya (2024).

6. Block-Wise Tribal Communities and Natural Resources

6.1 Tehsil-level analysis (Census 2011, class A and C)

Published counts of Scheduled Tribes and literacy are available by census tehsil (sub-district). Seven tehsils are shown separately; Jodamba, M.V. 79, Motu and Paparmetla are combined because their individual counts were not retrieved, and their figures are the district totals minus the seven (rounded).

Table 4. Tribal composition, literacy and density by tehsil, Census 2011

Tehsil	Population	Area (km ²)	Persons per km ²	ST (%)	SC (%)	Literacy, age 7+ (%)	Share of district ST (%)
Mudulipada	29,614	420	70.5	70.5	6.8	42.1	5.9
Mathili	84,201	618	136.2	69.5	11.6	46.6	16.5
Chitrakonda	33,579	570	58.9	68.0	15.4	42.1	6.4
Podia	28,264	348	81.2	65.5	21.0	39.9	5.2
Malkangiri	177,657	1,191	149.2	57.9	23.6	52.2	29.0
Orkel	74,584	441	169.1	53.3	22.5	52.7	11.2
Kalimela	76,811	825	93.1	40.9	34.0	52.3	8.9
Four others†	108,482	1,377	78.8	55.1	28.2	44.5	16.9
District	613,192	5,791	105.9	57.8	22.6	48.5	100.0

†Jodamba, M.V. 79, Motu and Paparmetla combined.

Scheduled Tribes are at least two-thirds of the population in Mudulipada, Mathili, Chitrakonda and Podia (Figure 4). Kalimela has the lowest tribal share (40.9%) because Scheduled Castes are 34.0% of its people, a pattern that fits the resettlement of Bengali-speaking refugee families. Malkangiri tehsil holds the most tribal residents (102,857, or 29.0%) because it is the largest, but the smaller tehsils are the most tribal.

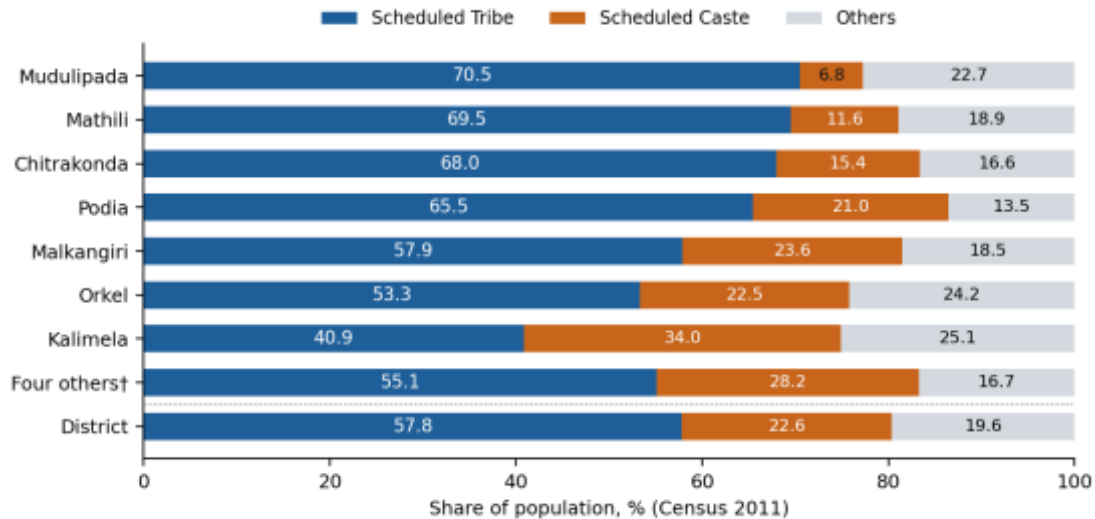


Figure 4. Population composition by tehsil, Census 2011. †Four combined tehsils. Source: Census of India 2011 as compiled by City Population; computed by the author.

Across the seven separately counted tehsils, literacy falls as the ST share rises (Figure 5a): the Pearson correlation is -0.78 and the Spearman rank correlation -0.71 , with about 4.0 points lower literacy for each 10-point rise in ST share ($R^2 = 0.61$, two-sided p of about 0.04). With seven points this is a pattern, not a proof. It is a tehsil-level association, and literacy covers all residents, so it is not tribal literacy; part of the difference reflects settler populations in higher-literacy tehsils. In Chitrakonda rural literacy is 34.4% and rural female literacy 21.2%, against 70.4% in its small urban area.

Total density is highest in Orkel (169 persons per km^2), Malkangiri (149) and Mathili (136) and lowest in Jodamba (43) and Chitrakonda (59) (Figure 5b). Counting only Scheduled Tribes, the load is heaviest in Mathili (95 per km^2), Orkel (90) and Malkangiri tehsil (86). An equal-weight screening score of ST share and illiteracy ranks Mudulipada and Podia highest (92 out of 100 each), then Chitrakonda (87), Mathili (72), Malkangiri (31), Orkel (21) and Kalimela (2). This is a relative ranking for choosing where to start, not a measure of climate vulnerability.

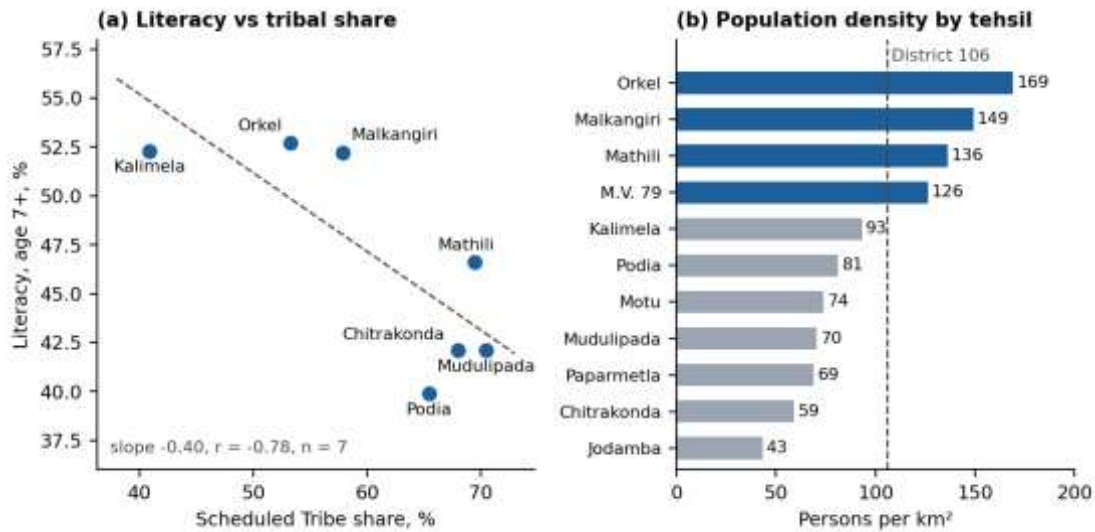


Figure 5. (a) Literacy against Scheduled Tribe share (seven tehsils); (b) population density by tehsil (dark bars above the district average). Sources: Census of India 2011; Villageinfo tehsil areas; computed by the author.

6.2 CD-block administrative scale (class B, indicative)

The legacy source table lists seven CD blocks under the older administrative arrangement. The KBK Development Authority (n.d.) publishes GP and village counts for that arrangement. The user-provided reorganisation states that Kudumulgumma has been merged under Khairput and a new Chitrakonda block has been formed. Since official village-level boundary crosswalks and recalculated block totals were not supplied, the legacy figures below are retained only as historical/indicative values and must not be reported as current-boundary statistics. ST counts come from a secondary tribal atlas compilation; they sum to 355,549 against the Census total of 354,614 and remain provisional.

Table 5. CD blocks: administrative scale and indicative ST counts

Block	Gram Panchayats	Villages	Villages per GP	Indicative ST count	Share of atlas total (%)	Tribal groups reported
Kalimela	21	131	6.2	47,598	13.4	Koya, Kondadora, Paroja, Gadaba, Kandha
Khairput	9	96	10.7	31,379	8.8	Bonda, Didayi, Bhumia, Gadaba, Kandha, Paroja
Korukonda	24	161	6.7	79,055	22.2	Koya, Paroja, Gadaba, Dhruva, Bhumia, Didayi, Bonda

Block	Gram Panchayats	Villages	Villages per GP	Indicative ST count	Share of atlas total (%)	Tribal groups reported
Kudumulugumma	11	236	21.5	47,683	13.4	Didayi, Bonda, Paroja, Kandha, Bhumia, Gadaba
Malkangiri	13	104	8.0	45,322	12.7	Koya, Bhumia, Paroja, Gadaba, Kandha, Bonda
Mathili	20	135	6.8	69,957	19.7	Bhumia, Koya, Dhruva, Holva, Paroja, Gadaba, Kandha
Podia	10	66	6.6	34,555	9.7	Koya, Kandha, Paroja
Total	108	929	8.6	355,549	100.0	

Group presence does not mean dominance in every village. Korukonda and Mathili hold the largest ST counts (22.2% and 19.7% of the atlas total). Kudumulugumma has the heaviest outreach load, with 21.5 villages per GP against 6.2–10.7 elsewhere (Figure 6): the same service team must cover three times as many settlements. The Bonda are reported in Khairput block (including the Mudulipada area), which has the smallest ST count but the highest PVTG sensitivity.

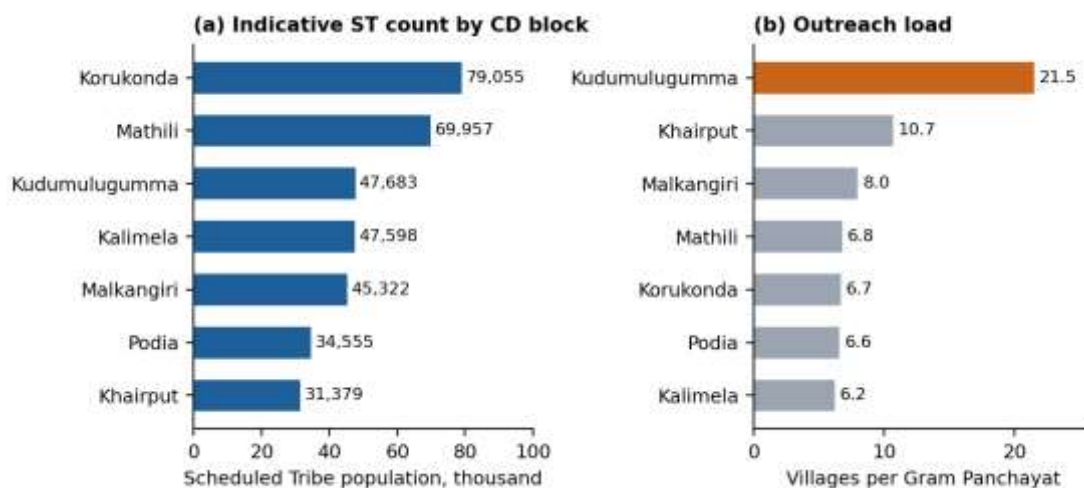


Figure 6. (a) Indicative Scheduled Tribe population by CD block (secondary atlas compilation, class B); (b) villages per Gram Panchayat. Sources: Tribal Atlas of Odisha; KBK Development Authority block list; computed by the author.

6.3 Natural resource availability

Block-level inventories of forest, soil, irrigation, springs, NTFP output or fish catch were not found in the sources used. Resources are therefore described at district level and per person.

Table 6. District-level natural resource indicators

Indicator	District value	Meaning per person or household
Forest cover (2023)	39.9% of area, about 2,312 km ²	About 0.65 ha per ST resident if shared equally
Recorded forest area (KBK)	3,355.88 km ² , 58.0%	Basis for legal and rights planning
Net sown area (CGWB)	1,158.9 km ² , 20.0% of area	0.19 ha per resident; 0.84 ha per household (137,599 households)
Cultivable area (CGWB)	1,311.7 km ²	About 153 km ² (12%) is cultivable but outside net sown area
Groundwater development (CGWB)	8.76%	Low draft, so scope to expand, but aquifer yields are site-specific
Annual rainfall (IMD normal)	1,514.5 mm; 84% in June–September	Short, intense wet season and a long dry season

6.4 Block-wise adaptation priorities (planning hypotheses)

Table 7. Resource systems, risks and priority packages by CD block

Block	Resource systems to map	Climate risks to test locally	Priority package (indicative)
Kalimela	Upland and lowland farms; millets and pulses; forest patches; ponds and streams; livestock	Monsoon breaks, slope erosion, crop stress, fire	Millet–pulse intercropping; contour bunds and mulching; CFR and NTFP plans; seed banks; women-led drying centres
Khairput	Bonda and Didayi resource areas; hill farms; springs; forest foods and medicinal plants	Dry-season water access, heat, nutrition stress, fire	Community-led spring protection; nutrition gardens and traditional crops; PVTG-approved microplans; local-language alerts
Korukonda	Forest–farm mosaic; paddy and upland crops; streams and ponds; NTFP routes	Flash runoff, soil loss, dry spells, price swings	Ridge-to-valley watershed; millet and pulse clusters; NTFP grading and storage; fodder and vaccination; last-mile market access
Kudumulugumma	Dispersed villages; forest livelihoods; water sources; PVTG settlements where confirmed	Remote hamlet isolation, water reliability, heat, heavy-rain disruption	Village resource plans; spring and pond revival; decentralised storage and solar drying; mobile health and extension

Block	Resource systems to map	Climate risks to test locally	Priority package (indicative)
Malkangiri	Farm–market interface; vegetables, paddy, millets; processing nodes; fisheries where access is lawful	Heat, market shocks, intense rain, drainage	Aggregation and processing hubs; cold and dry storage; crop advisories; drainage and water harvesting; fair producer pricing
Mathili	Rain-fed farms; mixed crops; forest products; livestock; streams and tanks	Rainfall variability, erosion, moisture deficit, forest degradation	Millet revival and mixed cropping; farm ponds and percolation works; NTFP cooperatives; agroforestry; animal health
Podia	Koya localities; upland farms; forest produce; Sabari-side water systems	Dry spells, erosion, access constraints, shifts in forest produce	Koya-led seed and food plans; millet–pulse systems; knowledge documentation; water harvesting; NTFP value addition

Tehsil clusters. The tehsil data suggest three working clusters. (A) A tribal forest and hill belt (Mudulipada, Chitrakonda, Podia), with ST 65–71%, literacy 40–42% and the highest screening scores, calls for community forest rights, NTFP value chains, millets and nutrition, spring protection and PVTG habitat plans. (B) A tribal-majority farming plateau (Mathili), with 95 ST persons per km², calls for watershed works, millet–pulse systems, supplementary irrigation and producer groups. (C) Mixed tribal and settler tehsils (Malkangiri, Orkel, Kalimela and probably M.V. 79 and Paparmetla) call for irrigation efficiency, fisheries cooperatives, vegetable and processing clusters, skills, urban water and heat plans, and fair sharing of commons. The resource base in each cluster is inferred and must be confirmed with forest cover, rainfall and land-use layers.

7. Livelihood System and Adaptation Options

Agriculture and millets. Tribal farming combines lowland paddy with upland finger millet, little millet, sorghum, maize, niger and pulses. These mixed systems are tolerant of poor soils and variable rain, but cash-crop shifts have raised costs and risk. The Odisha Millets Mission, launched in 2017 for tribal areas, has increased millet cultivation, yield rates and gross value per household, and offers a model for livelihoods, nutrition and climate resilience (Samtani et al., 2024). Priorities are seed banks of local landraces, procurement and processing linked to the public distribution system and school meals, soil and moisture conservation, short-duration varieties and low-external-input farming. Improved fallows, agroforestry and secure tenure are better responses to shifting cultivation than prohibition.

Forests, NTFPs and rights. NTFPs fill the lean-season gap. In a Kandhamal study of 64 households, NTFP collection provided 37% of employment days, mahua alone supplied 66% of NTFP income, and villages under community forest management showed regeneration of degraded forest patches (Mishra et al., 2023b). Forest rights are the legal base: FRA implementation in Odisha has been reviewed for process, constraints and outcome (Sarap et al., 2013), and its focus on individual claims at the expense of community rights is noted by Badu et al. (2026). A 2026 survey of 150 Juang households in Keonjhar found that FRA gains for livelihoods remain constrained by implementation gaps in land rights,

livelihood options and education (Jena et al., 2026). Recognition therefore needs post-recognition support: community forest management plans, sustainable harvest rules, primary processing by women's groups, and fire control.

Water and watersheds. Ridge-to-valley treatment, spring and pond revival, farm ponds, percolation works and equitable micro-irrigation address the dry season (Figure 3) and the heavy rain events (Mohanty & Sahu, 2026). A study of 160 farmers in four watershed areas of Koraput and Mayurbhanj argues that watershed development can play a transformative role for marginalised tribal farmers (Mishra et al., 2023a). With only 8.76% of groundwater developed (Table 6), site-specific recharge and lift options need technical screening for yield and equity.

Livestock, fisheries, energy and enterprise. Backyard poultry, goats and pigs act as savings and risk buffers and need vaccination, shelter and fodder. Balimela and pond fisheries need cooperatives with tribal access rights. Clean cooking and solar drying and pumping reduce fuelwood pressure and post-harvest loss. Self-help groups under Mission Shakti and the Odisha Livelihoods Mission are the main platform for aggregation and processing.

Information, health and risk transfer. Local-language agromet advisories, automatic weather stations, heat action plans, vector surveillance, grain banks and crop and livestock insurance help households anticipate shocks.

PVTGs. Programmes for Bonda and Didayi communities must be demand-driven, culturally safe and aligned with micro-project plans and habitat rights. Evidence on the Odisha PVTG livelihood programme reports no clear livelihood effect in a review of its evaluation, which argues for community-designed rather than externally imposed packages (Badu et al., 2026).

8. Holistic Development Model: Eight Pillars

A resilient future needs a “watershed–forest–farm–market–human development” model that replaces isolated infrastructure works with village packages. This approach is consistent with evidence that durable collective resource governance depends on locally legitimate institutions and rules (Ostrom, 1990).

Table 8. Eight-pillar framework

Pillar	Key actions	Lead schemes and platforms
1. Rights and governance	Complete pending IFR and CFR claims; community forest management plans; Gram Sabha capacity under PESA; record customary access; free, prior and informed consent	FRA 2006; PESA 1996; ST & SC Development Department
2. Climate-smart food systems	Millet and pulse diversity; seed banks; short-duration and drought-tolerant varieties; procurement linked to PDS and school meals	Odisha Millets Mission; Agriculture Department
3. Forest economy	Women-led groups for mahua, tamarind, honey, siali and sal leaves, broom grass; drying, grading, storage; native regeneration and fire prevention	MFP support; TRIFED; Mission Shakti

Pillar	Key actions	Lead schemes and platforms
4. Water security	Ridge-to-valley treatment; springs and ponds; recharge; each asset with a water balance, maintenance owner and access rules	PMKSY; MGNREGA; Jal Jeevan Mission
5. Livestock, fisheries, nutrition	Backyard poultry, goats, pigs; animal health workers; cooperative reservoir fisheries; nutrition gardens	Animal Resources and Fisheries Departments
6. Women, youth, enterprise, energy	SHGs and producer organisations for aggregation and processing; solar drying and storage; youth skills in repair, solar maintenance and data collection	OLM; Mission Shakti; skilling schemes
7. Climate information, health, access	Village rainfall and heat advisories in local languages; heat and vector plans; all-weather roads, culverts and transport services	IMD and agromet units; Health Department; PMGSY
8. Education, culture, PVTG safeguards	Oral and visual training; local languages; community-designed Bonda and Didayi microplans; protection of traditional knowledge	PM-JANMAN; micro-projects; tribal education schemes

9. Government Status in 2026 and Future Prospects

As of October 2026, Malkangiri is free of declared active Maoist presence, which lets the state deliver services where it could not before. Swabhiman Anchal still lacks basic services, and the large rail and health projects are not complete. Items below are class D (reports and announcements).

Table 9. Government status of Malkangiri, October 2026

Area	Status
Security	Odisha Police declared the district free of Maoist presence on 4 February 2026 after the last active Area Committee member surrendered; 31 March 2026 is also cited as the national target date. Arms dumps were still being found in June–August 2026 and clearance operations continue.
Rural development	On 6 May 2026 the state inaugurated 31 completed projects worth Rs 318.92 crore and laid foundations for 30 more worth Rs 184.63 crore under Bikashita Gaon, Bikashita Odisha; 168 PMGSY roads were announced.
Swabhiman Anchal	A 46 km concrete road from Papulur to Kalimela was built about three years ago but by July 2026 no buses or autos ran on it, and many villages lacked electricity and healthcare. Rs 101 crore was sanctioned in 2023 for three bridges in Chitrakonda block.
Air	Airport opened January 2024; trial flight 22 July 2026; a nine-seater service to Bhubaneswar was scheduled for 3 September 2026 (running status to be confirmed).

Area	Status
Rail	The 126 km Jeypore–Malkangiri line (Rs 2,343.6 crore, 75% Railways and 25% state) had tenders invited by April 2026 and needs about 1,056 acres across 71 villages. The 173 km Malkangiri–Bhadrachalam line (Rs 2,800 crore) was reported sanctioned but not started in an older report.
Health and education	An Ayurvedic medical college was named as upcoming in May 2026; the 2026–27 state budget proposes three Ayurvedic colleges statewide.
Tribal schemes	PM-JANMAN (Rs 24,104 crore, planned for 2023–24 to 2025–26) and Dharti Aaba Janjatiya Gram Utkarsh Abhiyan (Rs 79,156 crore, launched 2 October 2024) apply to Bonda and Didayi settlements and tribal villages; district-level progress was not found.

Prospects. Roads, the airport and the planned rail line can cut the cost of moving millets, NTFPs, fish and vegetables, but the gain reaches tribal producers only if collection, storage and processing are organised through women’s groups and producer federations. The rail line needs land in 71 villages, so compensation, Gram Sabha consent under PESA and FRA and protection of forest and grazing commons should be settled before work starts. The Swabhimán Anchal road shows that infrastructure alone does not deliver services: transport operations, power, health staff and schools need the same attention as construction. Convergence of PMGSY, MGNREGA, Bikashita Gaon Bikashita Odisha, Dharti Aaba and the Millets Mission at Gram Panchayat level can finance watershed works, seed banks, springs and heat and health preparedness. Risks include hidden explosives in forests, delayed land acquisition, unplanned plantations or tourism that erode commons, and thin village-level data.

10. Roadmap and Monitoring

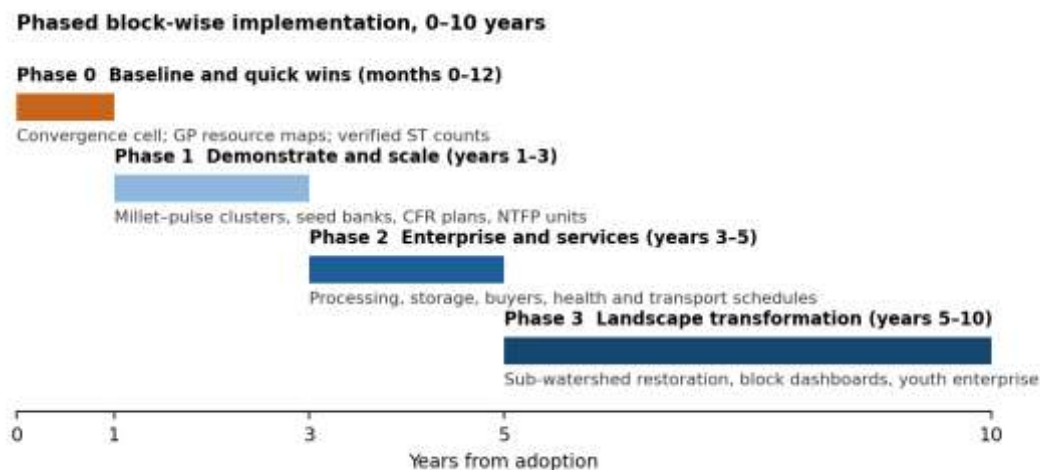


Figure 7. Phased block-wise implementation, 0–10 years.

Table 10. Roadmap deliverables

Phase	District and block actions	Deliverables
Months 0–12: baseline and quick wins	District convergence cell; block resource teams; participatory mapping in each GP; verify Census ST counts; inventory springs, ponds, NTFPs, crops, irrigation, forest rights and vulnerable hamlets; local advisory channels	Block baselines; GP resource maps; privacy-safe vulnerable household list; 3–5 priority works per GP
Years 1–3: demonstrate and scale	Pilot millet–pulse clusters, seed banks, spring revival, watershed treatment, CFR plans, women-led NTFP aggregation and livestock services in contrasting settings; before-and-after measurement	Demonstration clusters with baseline and follow-up data; maintenance committees; price transparency
Years 3–5: enterprise and services	Scale proven processing and storage; connect producers to buyers; solar drying and cold chain only where business cases hold; improve transport, health and extension schedules	Sustained producer organisations; lower post-harvest loss; higher net income; audited benefit sharing
Years 5–10: landscape transformation	Integrate forest, farm and water at sub-watershed scale; institutionalise block dashboards and climate finance; review scenarios every 3–5 years	Resilient livelihood portfolios; maintained ecosystem services; durable local institutions

Table 11. Baseline and monitoring indicators (disaggregate by block, GP, gender, tribal group and remoteness)

Domain	Core indicators
People	Households; ST and PVTG composition; literacy; school attendance; nutrition; health access; migration
Farms	Crop area by crop and variety; millet and pulse diversity; yield; input cost; irrigation; erosion; crop-loss events
Forests and NTFPs	CFR and IFR status; forest condition; fire events; harvest volumes; collector price and net income; women's participation
Water	Seasonal function of springs and ponds; pre- and post-monsoon discharge; drinking-water reliability; irrigated area; quality
Enterprise	SHG and producer-group membership; processing use; post-harvest loss; buyer diversity; margins; payment delays
Climate and disaster	Rainfall, dry-spell days, heat days, extreme-rain events, road-isolation days, climate-related losses
Governance and equity	Gram Sabha participation; claims processed; benefit distribution; grievance resolution; asset functionality and maintenance funds

11. Institutional Convergence and Financing

Gram Sabha and GP microplans should align, not duplicate, existing programmes under a district convergence cell covering tribal development, forest, agriculture, horticulture, watershed, water supply, fisheries, animal resources, health, education, disaster management and Mission Shakti.

Table 12. Convergence platforms and safeguards

Instrument or platform	Contribution	Safeguard or condition
FRA 2006 and PESA 1996	Tenure security; community resource governance	Verify eligibility and due process; do not treat recognition as automatic or complete
MGNREGA and watershed programmes	Labour and durable soil and water assets	Technical design, water balance, quality audit, maintenance funding
Odisha Millets Mission	Seed systems, production, processing, procurement, nutrition	Local varieties over hybrid monocultures; fair procurement and real demand
Odisha Livelihoods Mission and SHGs	Collective enterprise, credit, women's leadership	Transparent pricing; women's control of income
TRIFED and state tribal marketing	Aggregation and price support for eligible minor forest produce	Confirm current eligibility, rates and reach
PMKSY and Jal Jeevan Mission	Watershed, irrigation, drinking water	Equitable access; source sustainability; functionality monitoring
PM-JANMAN and micro-projects	Targeted services for eligible PVTG settlements	Confirm guidelines and eligibility; respect cultural privacy
Odisha State Action Plan on Climate Change 2021–2030	Policy alignment	Use updated versions and measurable adaptation indicators

12. Challenges, Safeguards and Research Priorities

Challenges and safeguards.

- Data gaps:** no downscaled district projections, few weather stations and few longitudinal studies; block-wise ST counts do not reconcile with the Census.
- Rights and governance:** incomplete community forest rights, weak Gram Sabha capacity and elite capture.
- Markets:** low procurement coverage in remote hamlets, limited processing, trader dependence; do not build processing plants without supply assessment, buyer commitments, power and transparent accounts.
- Remoteness:** access gaps remain for health, extension and markets.
- Social vulnerability:** gender inequity, malnutrition, low literacy and indebtedness; report who gains and who bears costs.

6. **Maladaptation:** water-intensive crops in water-stressed places, exotic plantations, unplanned tourism or mining, infrastructure that fragments forests or blocks drainage.
7. **Consent:** settle land and forest rights, Gram Sabha processes and compensation before interventions affect commons.
8. **Climate uncertainty:** design for both dry spells and intense rain, and update plans as projections improve.
9. **Project cycles:** short project cycles leave little handover or financing for community institutions.

Research priorities. (1) Downscaled climate projections and a vulnerability index for Malkangiri blocks; (2) reconciliation of block-wise ST counts with the official Census CD-block tables; (3) trend tests in Table 2 using IMD gridded data; (4) evaluation of the Millets Mission and community forest rights in the district; (5) valuation of forest and millet livelihoods under climate scenarios; (6) documentation of tribal ecological knowledge, including weather indicators; (7) gender-disaggregated and PVTG-specific adaptation studies; and (8) migration, health and heat exposure among tribal workers.

13. Conclusions and Immediate Decisions

Malkangiri's tribal communities have managed resources and climate variability for generations, and their farming and forest systems carry real resilience. Climate stress, forest degradation, weak markets and service deficits now strain them. Evidence suggests resilience will come from combining secure rights over land, forests, and water; millet-centred, diversified agriculture; sustainable NTFP value chains; watershed and water security; livestock and fisheries; clean energy; and reliable climate information and finance, anchored in strong Gram Sabhas and women's collectives. The district's data problems are real: normals differ by up to 600 mm, forest estimates by 33 percentage points, and block-wise tribal counts are not yet reconciled. Fixing the evidence base is therefore the first step of the plan, not a separate task.

Recommended immediate decisions.

1. Adopt a block-wise climate-resilient natural resource plan as an operational mandate, with Gram Sabha-led village resource mapping as the first step.
2. Within 12 months, build an official baseline from the Census CD-block tables, forest records and consistent IMD rainfall and temperature series, and adopt the IMD normal as the planning rainfall baseline.
3. Select pilot Gram Panchayats in contrasting settings (PVTG hill hamlets, Swabhimani Anchal reservoir borders, upland rain-fed farms, forest-farm mosaics, market-connected settlements) with community consent and transparent criteria.
4. Fund packages, not single assets: rights, seed and food diversity, water, forest governance, women-led enterprise, health and early warning, and last-mile services.
5. Publish an annual block dashboard on income, food-secure months, crop diversity, NTFP returns, water reliability, ecosystem condition, women's participation and service access.

Success should be measured by safer and more diversified livelihoods, stronger community rights, healthier ecosystems, reliable services and lower losses in climate shocks, not by expenditure or infrastructure counts alone.

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