



ADAPTATION FUND

AFB/PPRC.38/Inf.37
25 September 2026

Adaptation Fund Board
Project and Programme Review Committee
Thirty-eighth Meeting
Bonn, Germany, 19-23 October 2026

PROPOSAL FOR INDIA



ADAPTATION FUND

ADAPTATION FUND BOARD SECRETARIAT
TECHNICAL REVIEW OF PROJECT PROPOSAL FOR
"ENHANCING COMMUNITY AND ECOSYSTEM CLIMATE RESILIENCE IN THE NILGIRI–
WAYANAD CORRIDOR"

Project Title Enhancing community and ecosystem climate resilience in the Nilgiri–Wayanad Corridor

Project ID AF00000582

Category Regular size project (over \$1 million)

Type Single country project

Stage Concept

Country India

Implementing Entity UNEP

Financing Requested USD 15,000,000.00

Reviewer Eveline Vasquez

Co-reviewer(s)

IE Contact Person

Catherine Okoch, Jessica Troni, Ruth Mutinda

Secretariat's Overall Comment

The project Enhancing community and ecosystem climate resilience in the Nilgiri– Wayanad Corridor aims to reduce climate vulnerability and strengthen the resilience of communities, ecosystems, and local governance systems in the Nilgiri–Wayanad Corridor through integrated, landscape-scale climate adaptation investments that address landslide risks, hydrological instability, ecosystem degradation, invasive species impacts, and climate-sensitive livelihood vulnerabilities.

The proposal includes a request for a project formulation grant of USD 150,000.

The initial technical review raises several issues, including the coherence and consistent articulation of the Theory of Change and results framework across the proposal, the substantiation of cost-effectiveness and financing assumptions, the sustainability and scalability of the proposed interventions, and the consistency of project financing and indicators across different sections of the proposal, as discussed in the Clarification Requests (CRs) and Corrective Action Requests (CARs) raised in the review.

Country Eligibility

Is the country party to the Kyoto Protocol, or the Paris Agreement?

Response: Yes

Secretariat: - Kyoto Protocol: India ratified it on 26 August 2002.

- Paris Agreement: India signed it on 22 April 2016 and ratified it on 2 October 2016.

Is the country a developing country particularly vulnerable to the adverse effects of climate change?

Response: Yes

Secretariat: India is highly vulnerable to the adverse effects of climate change due to its extensive exposure to extreme heat, floods, droughts, cyclones, sea-level rise, and changing rainfall patterns, compounded by high population density and dependence on climate-sensitive sectors such as agriculture and water resources

Project Eligibility

Has the designated government authority for the Adaptation Fund endorsed the project/programme?

Response: Yes

Secretariat: LOE signed by Ms. Rajasree Ray - Designated Authority

Date: 20th July 2026

Does the length of the proposal amount to no more than Fifty pages for the project/programme concept, including its annexes?

Response: Not Cleared

Secretariat: The CN is 51 pages long; however, the annexes exceed 100 pages.

CAR1:

- Please revise and reduce the annexes to comply with the maximum limit of 50 pages.
- Ensure that all figures, tables, annexes, and supporting documents referenced in the text are included.
- Review internal references, component numbering, output numbering, and cross-references for consistency throughout the document.

Does the project / programme support concrete adaptation actions to assist the country in addressing adaptive capacity to the adverse effects of climate change and build in climate resilience?

Response: Not Cleared

Secretariat: Overall, the project presents relevant activities to address the identified climate change impacts, going beyond business-as-usual interventions. The activities have the potential to deliver tangible adaptation outcomes and are broadly aligned with the project's objectives and relevant Adaptation Fund Strategic Objectives. Nevertheless, further clarification and revisions are needed to strengthen internal consistency and the linkages between activities → outputs → outcomes → expected adaptation results, as indicated below.

CAR 2: Project objective, Theory of Change and results chain

The presentation of the overall project objective and the specific objectives lacks clarity and creates inconsistencies between the "Project/Programme Objectives" section and the Theory of Change. Please revise as follows:

1. Clearly distinguish the overall project objective from any specific objectives, as applicable, and ensure consistency between the "Project/Programme Objectives" section and the ToC.
2. Present the main climate adaptation problem first, followed immediately by the overall project objective. The ToC should clearly illustrate the transition from problem to intended change
3. Ensure that the ToC clearly shows the causal pathway from climate vulnerabilities and barriers → project activities → outputs → outcomes → expected adaptation impact.
4. Clearly distinguish results levels (objective/outcomes/outputs) from project components, which should represent the implementation architecture.
5. Ensure that outcomes describe the expected changes/results, outputs represent the direct products or services delivered by the project, and activities clearly describe what the project will finance.
6. Include the key assumptions and risks affecting progression from outputs → outcomes and outcomes →

overall objective.

7. Include a clear ToC narrative explaining the causal pathways rather than reiterating the component descriptions.

8. Ensure full consistency between the ToC narrative and diagram, project components, results framework, financing table, and other relevant sections of the proposal.

CAR3 – Unidentified Sub-Projects (USPs):

Could the IE assess whether any proposed activities or interventions qualify as Unidentified Sub-Projects (USPs) under the Adaptation Fund guidance, particularly where the specific interventions to be financed cannot yet be fully identified at the proposal stage, and, if applicable, revise the relevant sections of the proposal accordingly.

CR 1: Component 1 – vulnerability assessment, water-security logic and LEWS

Could the IE further clarify the technical and results logic of Component 1. In particular, please:

1. Specify the social vulnerability indicators to be considered (Output 1.1.1), including sex-disaggregated and other relevant socioeconomic/vulnerability indicators, and clarify how these will be integrated with landslide and flood hazard information in the four composite vulnerability maps.
2. Clarify how water insecurity is addressed under Component 1 (as indicated on page 20) and ensure that the proposed spring-shed rehabilitation and decentralized water-resilience measures, and their contribution to the intended outcome, are consistently reflected in the activities, outputs, outcome, ToC, and results framework.
3. Clarify the basis for the estimated 10,000–15,000 households to be covered by the 20 LEWS and how effective LEWS coverage will be measured. Please distinguish households covered by the warning systems from households reached through awareness activities and reconcile these figures with the beneficiary estimates presented elsewhere in the proposal.

CR 2: Component 2 – community nurseries and livelihood interventions

Could the IE further clarify the design, governance, and sustainability of the proposed community nurseries and related livelihood interventions. In particular, please:

1. Clarify how the operational status and sustainability of the four nurseries will be measured, including the expected production capacity and how this relates to the planting/restoration needs of the project.
2. Clarify what equipment support will be provided under Output 2.1.3, to which beneficiary groups, for which livelihood activities, and how this support is reflected in the activity description and budget.

CR 3: Component 3 – decentralized water systems and quantitative targets

Could the IE clarify how the proposed activities will deliver the specific targets under Output 3.1.1, particularly the approximately 50 check dams, which are not explicitly reflected in the activities? It would also be useful to clarify whether the approximately 150 systems represent distinct systems to be newly constructed or rehabilitated under the project and how the targets will be distributed across the four districts.

CR 4: Component 4 – LSG integration, inclusive governance and climate-finance mechanisms

Could the IE further clarify and strengthen the design and results logic of Component 4, including the criteria for selecting the 20 LSGs and how uptake of the EbA integration toolkits will translate into climate-resilient and biodiversity-positive actions through annual budgets and development plans, including how such uptake and implementation will be measured? Please also clarify how gender-responsive and Indigenous Peoples-inclusive governance will be incorporated and measured under Outcome 4.1 and reflected in the corresponding outputs and indicators. In addition, please clarify the role of the identified potential financing sources, including GEF, GCF, NAFCC, state climate funds, CSR, and multilateral banks, and how delivery of the two blended-finance mechanisms would be ensured if the anticipated external financing is not mobilized, considering that the proposal indicates that all project outputs and targets are fully deliverable through the Adaptation Fund grant alone.

CAR 3: Component 5:

Could you please clearly identify and describe the outcomes, outputs, and activities under Component 5? Could the IE further clarify and structure the proposed M&E and Knowledge Management component by clearly identifying the corresponding activities, outputs, outcomes, and expected impact? The current description focuses primarily on the M&E framework and indicators, but does not clearly distinguish the activities and outputs that will generate the expected outcomes and contribute to the overall project impact.

Does the project / programme provide economic, social and environmental benefits, particularly to vulnerable communities, including gender considerations, while avoiding or mitigating negative impacts, in compliance with the Environmental and Social Policy and Gender Policy of the Fund?

Response: Not Cleared

Secretariat: The project is expected to provide economic, social, and environmental adaptation benefits, particularly to vulnerable communities, through climate-resilient livelihoods, ecosystem restoration, water security, disaster risk reduction, and strengthened local planning and governance. While the prioritization of vulnerable groups is well justified and the proposed activities are broadly consistent with the Fund's Environmental and Social Policy and Gender Policy, further clarification is needed regarding the number, distribution, and potential overlap of beneficiaries across components.

CR 5: Economic, social and environmental benefits and beneficiaries

Please strengthen the presentation of the project's expected economic, social, and environmental adaptation benefits, ensuring that the main benefits are clearly defined and that the basis for any quantitative estimates is explained. Please also provide the overall number of direct and indirect beneficiaries, explaining how these figures were estimated and disaggregating them by gender and relevant vulnerable groups, including Indigenous Peoples. In addition, please clarify how beneficiaries are distributed across components, outputs, and livelihood activities, including any overlaps and how these will be accounted for to avoid double counting when estimating the total number of unique beneficiaries. Please ensure that beneficiary figures are consistent across the narrative, ToC, component descriptions, results framework, and relevant AF Core Indicator reporting.

CAR 4: Initial Gender Analysis

Please include/strengthen the Initial Gender Analysis required at Concept Note stage, which may be based on desktop research, to assess the distinct needs, capacities, roles, knowledge, access to resources, and decision-making of women and men in the project context and intervention areas, including relevant intersecting vulnerabilities affecting Indigenous Peoples and other vulnerable groups. Please also consider how gender dynamics may evolve or influence participation in and access to project benefits, and ensure that the key findings are reflected in the design of relevant project activities, participation arrangements, and indicators.

Is the project / programme cost effective?

Response: Not Cleared

Secretariat: CR 6: Cost-effectiveness

Kindly strengthen the cost-effectiveness analysis to provide a clear and logical explanation for each component, including a brief comparison of the selected approaches against relevant alternatives or benchmarks and the basis for the quantitative cost-effectiveness claims presented. Where possible, please provide quantitative estimates; otherwise, relevant proxy estimates or benchmarks should be provided and the underlying

assumptions explained. In particular, please review and substantiate the cost and cost-effectiveness estimates presented for:

- (i) Component 1, including the USD 430–650 per household coverage cost and the unit costs for vegetative bunds and check dams, ensuring consistency with the relevant component/output budgets;
 - (ii) Component 2, including the estimated 30–40% reduction in restoration costs, the USD 700 cost per direct livelihood beneficiary household, and the projected livelihood-income improvements, ensuring consistency with nursery capacity, restoration targets, beneficiary figures, and the MGNREGS comparison; and
 - (iii) Component 3, including the unit costs for decentralized water interventions, the average USD 12,333 per system, and the stated 60–80% reduction in cost per household, using a consistent basis for comparison.
- (iv) Please also provide the cost-effectiveness rationale for Component 5.

CR 7: Please explain the cost-effectiveness of the proposed interventions from a sustainability perspective, including relevant recurrent and O&M costs where these materially affect the long-term viability of the interventions.

Is the project / programme consistent with national or sub-national sustainable development strategies, national or sub-national development plans, poverty reduction strategies, national communications and adaptation programs of action and other relevant instruments?

Response: Cleared

Secretariat: Yes.

As per information provided in Part II.E. The proposal discussed how the project is consistent with India's national and state climate change, adaptation, biodiversity, water-resource management, disaster-risk reduction, and sustainable development priorities, including the National Action Plan on Climate Change (NAPCC), the National Mission for Sustainable Agriculture (NMSA), National Mission on Sustainable Habitat (NMSH), Green India Mission (GIM), National Water Mission, National Biodiversity Action Plan (NBAP), India's Nationally Determined Contribution (NDC), and Mission LiFE. At the state level, the project is also aligned with relevant Kerala and Tamil Nadu climate and biodiversity strategies, including their State Action Plans on Climate Change, as well as the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals (SDGs).

Does the project / programme meet the relevant national technical standards, where applicable, in compliance with the Environmental and Social Policy of the Fund?

Response: Not Cleared

Secretariat: CAR 5: National technical standards

Please review Part II.F and strengthen the table of applicable national technical standards to ensure that all relevant standards are identified, including applicable building codes, water quality regulations, and other sector-specific standards, as relevant to the proposed activities. Please also clearly indicate the project's compliance status and, where further compliance actions are required, the main steps to achieve compliance.

Is there duplication of project / programme with other funding sources?

Response: Not Cleared

Secretariat: CR 8: Please revise and amend the table under Part II.G to include all related ongoing or completed projects. For each, please provide (besides the information already in the CN):

1. Main project interventions, and Target population,
2. Implementing entity,
3. Lessons learned, how they are considered/ reflected in the proposed project design by indicating specifically the proposed project's output that relates,
4. Potential overlaps and synergies with the proposed project,
5. A specific and sound justification for no duplication. This may be justified, for example, by indicating the distinct geographic locations and/or types of interventions
6. Please include any relevant regional projects and AF-funded projects, if they exist. Previous AF-funded projects may provide lessons learned that can support the project design.

CR 9: Could the IE further clarify how existing and ongoing watershed, water security, and ecological restoration initiatives will be considered in the selection of project sites and activities, to ensure complementarity, additionality, and avoidance of duplication?

Does the project / programme have a learning and knowledge management component to capture and feedback lessons?

Response: Not Cleared

Secretariat: CR 10: Could the IE further clarify how lessons learned, described in Part II.H, across the project components will be systematically captured, synthesized, and disseminated through the proposed knowledge management framework, including the mechanisms for incorporating these lessons into project implementation and sharing them with relevant local, national, and regional stakeholders? Please also clarify how these activities will be coordinated under Component 5 and correct the reference to "Component 10," as appropriate.

Has a consultative process taken place, and has it involved all key stakeholders, and vulnerable groups, including gender considerations in compliance with the Environmental and Social Policy and Gender Policy of the Fund?

Response: Not Cleared

Secretariat: Yes.

Stakeholder consultations conducted between January and February 2026 directly informed the project's design, priorities, and proposed interventions

CR 11: Could the IE provide gender-disaggregated attendance data for each stakeholder consultation meeting to clearly demonstrate the participation of women and men throughout the consultation process? In addition, the stakeholder consultation section refers to Figure 5, but the corresponding figure appears to be missing from the document. Please review and revise accordingly.

Is the requested financing justified on the basis of full cost of adaptation reasoning?

Response: Not Cleared

Secretariat: CR 12: Complementary financing

Please clarify whether other sources of funding are expected to support delivery of any part of the project, including the anticipated role of CAMPA, MGNREGS, state forestry schemes, and the National Mission for Green India. Please distinguish, as applicable, between existing complementary investments, indicative co-financing opportunities, and potential future financing, and clarify the basis for the stated 90:10 MGNREGS co-financing ratio. If the Adaptation Fund grant is sufficient to deliver all project outcomes and outputs independently of these additional sources, please clarify this accordingly.

CAR 6: Project funding amounts

Please review and reconcile the component-level funding amounts to ensure consistency between the “Justification for Funding Requested” table and the corresponding amounts reported throughout the proposal.

Is the project / program aligned with AF’s results framework?

Response: Not Cleared

Secretariat: CAR 7: Adaptation Fund Strategic Results Framework alignment

Please review and revise the table in Part III.A to ensure consistency with the Adaptation Fund’s revised Strategic Results Framework (SRF) and updated templates.

1. Please ensure that all project outcome and output indicators are SMART;
2. Please ensure that the project outcomes, outputs and corresponding indicators are appropriately aligned with the relevant AF Outcomes, Outputs and indicators.
3. Please ensure that the table follows the format of the updated AF Results Framework, (updated in July 2026): https://www.adaptation-fund.org/wp-content/uploads/2026/04/AF-SRF-Updated-templates_results-framework-table-and-results-framework-alignment-table.pdf

CR 13: Applicability of AF Core Indicators and treatment of co-benefits

Please review the applicability of the AF Core Indicators and ensure that the relevant indicators are consistently reflected in the project results framework and SRF alignment table. In particular, please consider Core Indicator 6 (policies, strategies and/or plans developed or adjusted to integrate climate risk and resilience considerations), given the proposed integration of climate risk and EbA into GPDs, DDMPs and local development plans. Please also clarify whether Component 2 is expected to contribute to Core Indicator 5 (households with increased income or avoided decrease in income) and, if so, ensure that the corresponding project indicator measures the relevant change in household income rather than only participation in livelihood activities. In addition, carbon sequestration and biodiversity are identified as a secondary co-benefit in the cost-effectiveness analysis (Part II.D); please clarify how these co-benefits are reflected in the results framework and, if it is intended to be measured, how it will be quantified and monitored.

Has the sustainability of the project/programme outcomes been taken into account when designing the project?

Response: Not Cleared

Secretariat: CR 14: Sustainability arrangements and O&M

The proposal provides a comprehensive description of the institutional, socio-economic, environmental, and financial sustainability of the project, including institutional ownership, community stewardship, an exit strategy, and arrangements for replication and scaling beyond project completion. Please further clarify the post-project O&M and recurrent resource arrangements for relevant project-supported systems and assets, including, as

applicable, water infrastructure, EWS, digital platforms, nurseries, and community-based monitoring systems, and indicate the expected sources of funding/resources for their continued operation. Please also clarify whether the institutional, O&M, financing, handover, or other sustainability arrangements described in the proposal are already in place, under preparation, or expected to be established during project implementation.

CAR 8: Sustainability – internal consistency and financial assumptions

The sustainability section provides clear institutional and financial pathways for the continuation of project benefits, including integration into government planning and budgeting systems, community-based livelihood mechanisms, and complementary financing opportunities. However, some elements would benefit from further internal consistency and clarification. Please clarify the respective roles of Components 3 and 4 in integrating climate resilience and EbA into LSG planning, budgeting, and coordination systems, and correct the component reference as applicable. Please also ensure that statements regarding the financial self-sustainability of livelihood enterprises and complementary and leveraged financing are consistent with the level of evidence and certainty provided in the proposal.

Does the project / programme provide an overview of environmental and social impacts / risks identified, in compliance with the Environmental and Social Policy and Gender Policy of the Fund?

Response: Cleared

Secretariat: The project is determined to be Category C according to the Adaptation Fund Environmental and Social Policy F's ESP (corresponding to Moderate risk category of UNEP's UNEP Environmental and Social Sustainability Framework).

Resource Availability

Is the requested project / programme funding within the cap of the country?

Response: Cleared

Secretariat: Yes.

The proposed budget is USD 15,000,000.

Is the Implementing Entity Management Fee at or below 8.5 per cent of the total project/programme budget before the fee?

Response: Cleared

Secretariat: Yes.

As per information provided in Table "Project/Programme Components and Financing" and PFG Form. The figures add up and match across the tables – components table vs. budget.

The Implementing Management Fee is exactly 8.5% (USD 1,175,115) of the Total Project/Programme Budget before fee. The requested PFG is correct in size (USD 150,000).

Are the Project/Programme Execution Costs at or below 9.5 per cent of the total project/programme budget (including the fee)?

Response: Cleared

Secretariat: Yes.

As per information provided in Table “Project/Programme Components and Financing”. All the figures are rounded to a whole number. They add up and match across the tables. The Project Execution Cost is exactly 9.5% (USD 1,313,364).

Eligibility of IE

Is the project/programme submitted through an eligible Implementing Entity that has been accredited by the Board?

Response: Cleared

Secretariat: UN Environment Programme (UNEP)

Accreditation status: Accredited (Special extension per Decision B.46/9)

Accreditation Expiration Date: 30 October 2027



ADAPTATION FUND

CONCEPT NOTE FOR REGIONAL PROJECT/PROGRAMME



ADAPTATION FUND

REGIONAL PROGRAMME PROPOSAL

PART I: PROJECT/PROGRAMME INFORMATION

Title of Project/Programme: Enhancing community and ecosystem climate resilience in the Nilgiri–Wayanad Corridor

Country/ Countries: India

Thematic Focal Area¹: Nature-based solutions and ecosystem based adaptation

Type of Implementing Entity: Multilateral Implementing Entity

Implementing Entity: United Nations Environment Programme

Executing Entities: Department of Environment and Climate Change of Tamil Nadu state-
Department of Environment and Climate Change of Kerala state

Amount of Financing Requested: 15,000,000 (in USD equivalent)

Project Formulation Grant Request: Yes ☒ No ☐

Amount of Requested financing for PFG: 150,000 (in U.S Dollars Equivalent)

Letters of Endorsement (LOE) signed for all countries: Yes ☒ No ☐

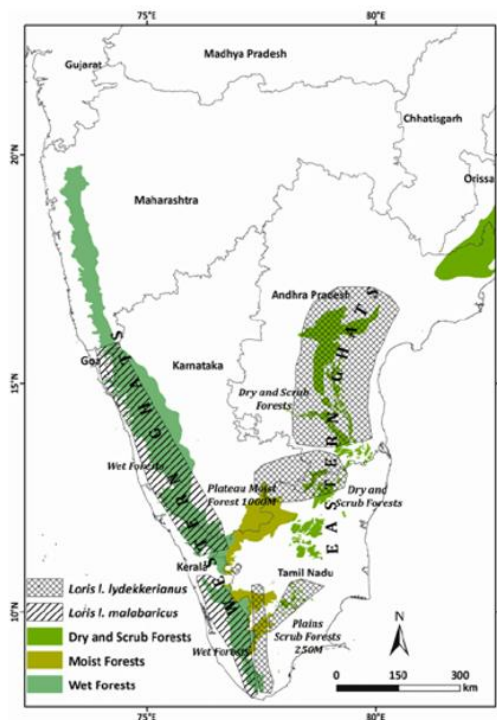
¹ Thematic areas are: Agriculture, Coastal Zone Management, Disaster risk reduction, Food security, Forests, Human health, Innovative climate finance, Marine and Fisheries, Nature-based solutions and ecosystem based adaptation, Protection and enhancement of cultural heritage, Social innovation, Rural development, Urban adaptation, Water management, Wildfire Management.

I. Project Background and Context:

India ranks 9th in the Global Climate Risk Index 2026 (Adil et al., 2025), with its high vulnerability driven by extreme weather events such as floods, heat waves, cyclones, and droughts. Heavy monsoon rains have triggered floods and landslides, displacing millions of people and causing significant damage to agriculture, highlighting the country's wide-ranging climate risks. Over 80 percent of the country's population lives in districts vulnerable to climate-induced hazards (UNEP, 2025). Increasing temperatures, shifting rainfall patterns, falling groundwater levels, melting glaciers, stronger cyclones, and rising sea levels pose serious threats to livelihoods, food security, and the overall economy (UNEP, 2025). Within this context, and given its ecological sensitivity and rising climate risks, the Ministry of Environment, Forest and Climate Change has proposed declaring 56,825.7 sq km of the Western Ghats as an Eco-Sensitive Area, underscoring the need to prioritise the region for focused climate adaptation planning and investment (MoEFCC, 2024). The project focuses specifically on the Nilgiri–Wayanad corridor, a defined mountain corridor within the Western Ghats, and does not constitute a broader Western Ghats programme.

The Western Ghats are a globally significant mountain range across six Indian states: Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu. Running parallel to the western coast, the Ghats form a continuous escarpment that shapes regional climate, hydrology, and ecosystems (Department of Environment and Climate Change, Government of Kerala [DoECC], 2022). They support exceptionally high biodiversity and endemism, including at least 325 globally threatened species such as the lion-tailed macaque, Nilgiri tahr, tiger, Asian elephant, and Nilgiri langur, alongside numerous endemic plants and birds including the Malabar grey hornbill and Nilgiri flycatcher (UNEP-WCMC, 2023). The Ghats also support diverse forest and grassland ecosystems that together sustain rich biodiversity, including numerous endemic and threatened species (UNEP-WCMC, 2023). As the hydrological heart of Peninsular India, the Ghats provide headwaters for numerous rivers and contribute up to 40–50% of regional moisture, sustaining both upstream and downstream communities (Paul et al., 2018). By intercepting moisture-laden southwest monsoon winds, the Ghats generate high rainfall on windward slopes (2,000–3,000 mm annually) and create pronounced rain-shadow conditions to the east (DoECC, 2022). Their climatic and elevational gradients make the region a critical ecological divide, regulating hydrology, climate, and ecosystem services across Peninsular India (UNEP-WCMC, 2023).

Figure 1: Map of forest type distributions in Western Ghats²



The Western Ghats are increasingly vulnerable to climate change. Over the past five decades, the region has experienced a five-fold increase in extreme weather events, including rising temperatures, erratic monsoon patterns, frequent floods and landslides, and prolonged dry spells (Environment Department, Government of Kerala [EDGK], 2025). Mean annual temperature in the Western Ghats is expected to rise by 1.5–2.0°C by 2050 (Vidya and Murthy, 2022), increasing heat stress and altering phenological cycles. In addition, the region faces multiple socio-economic pressures, including livelihood insecurity, encroachments, infrastructure expansion, and migration (EDGK, 2025). Evidence suggests that delays in resilience-building measures could substantially escalate future economic and social costs (Vidya and Murthy, 2022).

The states of Tamil Nadu and Kerala, which share this ecological landscape, are among the most climate-vulnerable in southern India (Vidya and Murthy, 2022). Their vulnerability is driven by a combination of high sensitivity to climate variability and limited adaptive capacity, particularly among rural, agrarian, and forest-dependent populations (Department of Environment and Climate Change, Government of Kerala [DoECC], 2022). Tamil Nadu is frequently affected by rising temperatures, erratic rainfall, droughts, and sea-level rise, with profound implications for water security, agriculture, and coastal ecosystems (Centre for Climate Change and Disaster Management (CCCDM), 2024). The state is heavily dependent on both the northeast (48%) and southwest (32%) monsoons, making shifts in

rainfall patterns especially disruptive (Centre for Climate Change and Disaster Management, 2024). Kerala is similarly

² Kumara, H, Singh, M and Irfan-Ullah, Mohammed, Kumar, (2013)

classified as a multi-hazard-prone state, uniquely exposed due to its location between the Arabian Sea and the steep escarpments of the Western Ghats (DoECC, 2022). Approximately 15.7% of the state's land area is flood-prone, while 14.4% is susceptible to landslides, and around 36.6–40% of the coastline is highly vulnerable to erosion and sea-level rise (DoECC, 2022).

Within the broader landscape, the Wayanad–Nilgiris landscape along the Nilgiri-Wayanad corridor (see Map in Figure 2) constitutes a critical sub-landscape and forested watershed located at the junction of Kerala and Tamil Nadu (Ministry of Environment, Forest and Climate Change [MoEFCC], 2013). This area serves as the primary source for major river systems including the Bhavani, Chaliyar, and Kabani, forming a hydrological backbone that is essential for regional water balance (MoEFCC, 2013). The landscape's steep and rugged terrain, combined with its dependence on stable monsoon patterns, makes it uniquely sensitive to climate change (CCCDM, 2024). As much of the agriculture in this landscape is rainfed, even small deviations in rainfall have severe impacts (CCCDM, 2024). Climate change has also affected agricultural production in the region, which has traditionally been fertile and well-suited for plantations, millets, paddy, and horticultural crops (DoECC, 2022). Forest fragmentation has disrupted slope continuity, contributing to increasingly fatal landslides, while unregulated development, including road construction on slopes steeper than 22 degrees and extensive quarrying, has destabilized the thin soil cover (MoEFCC, 2013). The conversion of natural vegetation to plantations and built-up areas has also obstructed seasonal streams, reducing the Nilgiris- Wayanad landscape's ability to naturally regulate runoff during heavy rainfall events (DoECC, 2022).

As high temperatures, droughts, forest fragmentation, and groundwater depletion increase, maintaining intact forested catchments becomes essential for ensuring water security, conserving biodiversity, and reducing disaster risks (CCCDM, 2024). If forest degradation continues, the Wayanad–Nilgiris landscape faces a future of cascading environmental failure: reduced forest cover limits soil absorption, increasing the velocity of surface runoff and triggering catastrophic landslides and flash floods, such as the 2024 Wayanad tragedy (UNEP, 2025). The loss of forest litter and root systems further undermines groundwater recharge, leading to seasonal droughts and the drying of traditional springs. Biodiversity is also at risk, with projections indicating that evergreen forests in the Nilgiris and Coimbatore may decline by up to 32% by 2050, gradually giving way to more arid forest types. Increased upstream erosion is resulting in siltation of downstream reservoirs and riverbeds, reducing their carrying capacity and heightening flood risks for downstream communities in Kozhikode and Malappuram districts (CCCDM, 2024).

The proposed project interventions will therefore focus on selected districts in Kerala (Wayanad, Kozhikode) and Tamil Nadu (Nilgiris, Coimbatore) within the critical Nilgiris Wayanad corridor (NWC) of the Western Ghats. The interventions are structured across three geographically distinct but hydrologically connected zones. The core intervention landscape includes the upper montane forested catchments of Wayanad (Kerala) and the Nilgiris (Tamil Nadu), which form key source areas of major river systems. The hydrologically linked secondary zone comprises the midstream valleys of Kozhikode (Kerala) and Coimbatore (Tamil Nadu), where rivers such as the Chaliyar and Bhavani carry water, sediment, and ecosystem services downstream. The downstream benefit zone includes communities, particularly in Kozhikode, that depend on these upstream systems for water security, flood regulation, and livelihood stability, and benefit indirectly from upstream restoration and risk reduction.

As part of the landscape approach, the project also recognises Malappuram district as a downstream benefit zone of the Chaliyar river basin, where upstream restoration and risk reduction investments in Wayanad and Kozhikode are expected to generate indirect hydrological and flood regulation benefits, and where project activities and models can be directly replicated given the shared ecological and socioeconomic context.

Together, these four districts span a combined area of approximately 14,577 sq km: Wayanad (2,130 sq km), Kozhikode (2,345 sq km), Nilgiris (2,453 sq km), and Coimbatore (7,649 sq km), of which the project will target specific forested catchments, degraded hotspots, and climate-vulnerable communities within the NWC corridor portions of each district (Census of India, 2011; Government of Kerala; Government of Tamil Nadu). These districts are prioritized for their key forested catchments, water tower function, and shared ecological characteristics, including contiguous montane forests, steep terrain, and high biodiversity. Protecting and restoring this landscape is critical to safeguard livelihoods, stabilize soils, maintain hydrological balance (CCCDM, 2024) and strengthen the climate resilience of local communities, including Indigenous Peoples, as well as downstream populations that depend on the regulatory and supporting ecosystem services of the Western Ghats.

Background and Context: Focused landscape Nilgiri–Wayanad Corridor (NWC)

a) Geographical context

The Nilgiri–Wayanad Corridor (NWC) (Map) connects the high-altitude Nilgiris (Tamil Nadu) and Wayanad (Kerala), integrating upstream forests and midstream valleys into a functionally connected socio-ecological landscape. Shared river

basins, continuous forests, and strong hydrological connectivity mean that degradation or climate stress in the upper montane zones directly increases soil erosion, sedimentation, and water-security risks. Elevations in this corridor range from approximately 700 to 2,600 meters, with steep slopes, shallow soils, and complex drainage patterns. Dominant ecosystems include montane shola–grassland complexes, interspersed with forest patches and plantations. These forests give rise to the headwaters of major river systems, including the Bhavani, Moyar, Kabini, and tributaries of the Chaliyar. High monsoonal rainfall, exceeding 2,300 millimeters annually in Wayanad, supports dense vegetation but also increases vulnerability to landslides and soil erosion. This vulnerability is evidenced by recent extreme rainfall triggered disasters in the corridor, including the 2024 Wayanad landslides, which resulted in over 400 deaths and widespread destruction of settlements, infrastructure, and plantations, with estimated economic losses exceeding ₹1,200 crore (Kerala State Disaster Management Authority, 2025). Similar high intensity rainfall events in the Nilgiris Western Ghats region have repeatedly

triggered slope failures and flash floods, reinforcing the corridor's high disaster sensitivity under climate change. The Chaliyar River, originating in the Ilambalari Hills of the Nilgiri Biosphere Reserve near Wayanad, forms the hydrological backbone of the corridor. Its tributaries, such as the Cherupuzha, Iruvanjippuzha, Kanjirappuzha, and Karimpuzha, regulate seasonal water flows, sediment transport, groundwater recharge, and ecological connectivity. Maintaining the integrity of this landscape is critical for sustaining the water tower function, stabilizing soils, conserving biodiversity, and reducing cascading environmental risks (CCCDM, 2024).

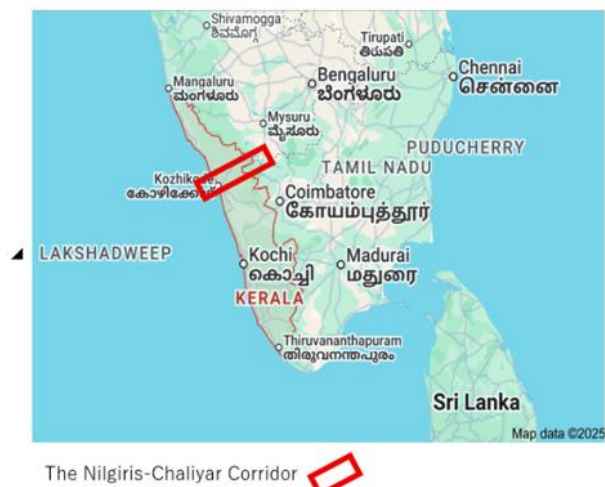


Figure 2: Map of Nilgiris Chaliyar Corridor- along Chaliyar River Basin³

For the purposes of this project, the NWC is defined as three nested geographies: (i) the core upper montane catchment zone (Wayanad highlands and Nilgiris plateau) targeted for direct ecosystem investments; (ii) the midstream transition zone (eastern Kozhikode highlands and western Coimbatore slopes) anchoring livelihood, governance, and finance interventions; and (iii) the downstream benefit zone (lowland Kozhikode) receiving indirect hydrological and flood-regulation benefits.

b) Socio-economic context

The NWC forms a contiguous socio-ecological landscape bridging Kerala and Tamil Nadu, supporting an estimated 1.5–2 million people. Kerala exhibits strong human development indicators, particularly in education and health, yet rural livelihoods remain structurally fragile. In highland districts such as Wayanad, agriculture is the dominant livelihood. Most landholdings are small and fragmented, with over 70% of cultivation rainfed, making production highly sensitive to monsoon variability. Key crops include rice, coffee, pepper, tea, coconut, and cardamom, which have suffered production losses of 20–50% during recent climate extremes (Sundaran et al., 2024). Youth out-migration has led to an aging and feminized rural labor force, while limited irrigation, poorly maintained infrastructure, and administrative fragmentation constrain adaptive capacity (UNEP, 2025; Mathew et al., 2018; Raj and Sofi, 2021; Ravindranath et al., 2018; Sripada, 2021). Indigenous communities, including the Toda, Kota, Badaga, Kattunayaka, Adiya, Paniya (a community traditionally employed as bonded laborers on plantations, many now working as daily wage agricultural laborers without land ownership) and Cholanaiikka, face livelihood stress due to insecure land tenure and declining access to forest resources, with Particularly Vulnerable Indigenous groups increasingly reliant on public support mechanisms (UNEP, 2025).

While Tamil Nadu is more urbanized overall, with 48.45% of the population residing in cities as of 2011 (projected to reach 70% by 2047; CCCDM, 2024), districts within the NWC such as the Nilgiris are largely rural and ecologically integrated with the highlands of Wayanad. Agriculture engages 60–70% of the rural population, with small and marginal landholdings contributing 8–9% to the state GDP; crops include rice, millets, pulses, sugarcane, cotton, tea, coffee, and spices. Plantation crops provide substantial employment but also introduce exposure to price volatility and limited diversification (UNEP, 2025).

³ UNEP AF Concept Note Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin

This continuity highlights the functional linkages of livelihoods, ecosystems, and water resources across the corridor, despite broader differences in urbanization and economy at the state level.

Income and employment across the NWC region are precarious. Households rely on small-scale farming, plantation labor, casual wage work, tourism, and forest-based activities (Alamgir et al., 2021). Climate shocks often put pressure on household resources, occasionally prompting the sale of assets and affecting resilience. Education and human capital are modest, with literacy among indigenous groups 15–20% lower than district averages (Census of India, 2011), constraining engagement with extension services, climate information, and livelihood diversification (Census of India, 2011; Hasan and Kumar, 2019; Sripada, 2021).

Human–wildlife conflict is an intensifying climate-driven stressor in the NWC. Climate change is affecting rainfall, temperature, vegetation, and water resources, which in turn modify wildlife habitat suitability and movement patterns across the corridor. Simultaneously, deforestation, plantation expansion, infrastructure development, and forest fragmentation have significantly reduced and degraded natural habitats, disrupting ecological connectivity and wildlife corridors. As forests become increasingly ecologically stressed and fragmented, animals are forced to move into agricultural landscapes and human settlements in search of food, water, and shelter (Raj and Sofi, 2021; Ravindranath et al., 2018). At the same time, farmers adapting to climate variability through crop diversification, agricultural intensification, and expansion into forest margins increase human activity within wildlife movement zones. These combined climate and anthropogenic pressures intensify human–wildlife conflict, making it a major socio-ecological challenge that must be integrated into climate adaptation and landscape management planning.

c) Environmental context

The NWC connects moist deciduous and evergreen forests of Wayanad with montane shola–grassland and evergreen systems of the Nilgiris. Steep slopes and elevation gradients create heterogeneous habitats, shola–grassland complexes, evergreen and moist deciduous forests, riparian systems, and mid-elevation agroforestry belts, that sustain biodiversity and regulating services (Nair et al., 2021; Subbarayan et al., 2021; Ravindranath et al., 2018). Hydrologically, it functions as a major headwater and recharge zone for the Kabini, Moyar, Bhavani, and Chaliyar rivers (Nair et al., 2021; Subbarayan et al., 2021; Ravindranath et al., 2018), contributing to soil stability, groundwater replenishment, and carbon storage (Nair et al., 2021; Subbarayan et al., 2021; Ravindranath et al., 2018).

Historical land-cover assessments reveal substantial forest loss over the long term. In Wayanad, forest cover declined by approximately 62% between 1950 and 2018, a transformation that has weakened the landscape’s capacity to regulate water and resist landslides (Sri et al., 2021). Across the broader corridor, forest extent has decreased by 35.3% over the past century (Sri et al., 2021). In the Nilgiris, data from 2000–2020 show a relatively modest net tree cover loss of –0.26% (–590 ha), but this headline figure masks significant internal degradation and the considerable conversion of critical montane grasslands and woody savannas within the biosphere reserve (Sri et al., 2021). Such changes underscore that apparent stability in overall tree cover can conceal the loss of structurally and functionally important ecosystems.

Land-use changes like deforestation, agriculture, plantations, settlements, and tourism, have fragmented habitats and reduced ecosystem resilience (Nair et al., 1978; Anoop, 2023; Sri et al., 2021; Ravindranath et al., 2018). Connectivity is restricted in key wildlife movement zones, including Wayanad’s elephant corridors (Naikatty–Ponkuzhi–Mulehole), while invasives like *Lantana camara* and *Senna spectabilis* dominate disturbed areas, suppressing native regeneration (Menon, 2023; Anoop and Ganesh, 2020). Hydrological function and soil stability have been altered by forest conversion, slope modification, drainage obstruction, and construction on steep terrain, amplifying runoff, sedimentation, landslide susceptibility, and flash-flood risk (Nair et al., 2021; Subbarayan et al., 2021; Sri et al., 2021). The heterogeneous elevational gradients that once supported a diversity of forest and grassland types are becoming more unstable under intensified land-use pressures and changing climate regimes.

d) Current climate context

Located in southern India, Tamil Nadu and Kerala have a semi-arid and tropical monsoon climate with high humidity levels due to their proximity to the sea. Both states are situated in a multi-hazard-prone region, frequently affected by extreme weather, including cyclones and intense rainfall events (CCCDM, 2024).

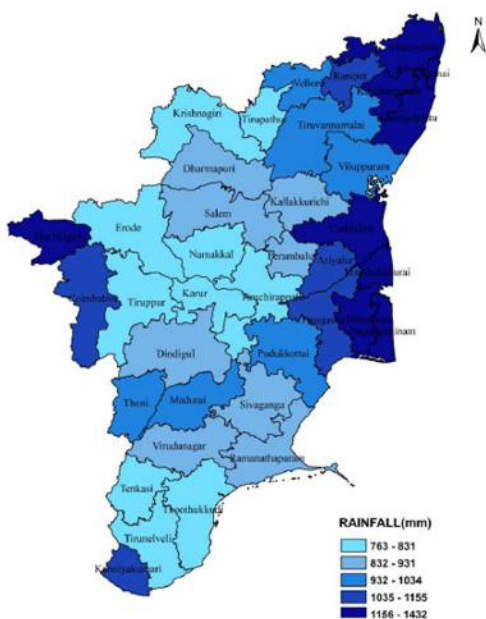


Figure 34: Spatial variations in observed annual rainfall of Tamil Nadu (1985-2014)

Observed climate trends: Observed climate data for Tamil Nadu and Kerala indicate a shift toward stochastic extremes, with increasing thermal stress, hydrological instability, and ecological degradation (DECC, 2022; Sundaran et al., 2024).

a) Temperature trends: Observed data reveal a significant warming trend across both states over recent decades. In Tamil Nadu, the average annual temperature has increased by nearly 1°C relative to the 1951–2020 baseline. Between 1985 and 2014, the annual maximum temperature rose at 0.2°C per decade, while the minimum temperature increased by 0.3°C per decade, indicating that nights are warming faster than days (CCCDM, 2024). The mean annual maximum temperature across the state is 32.5°C, ranging from 33.4°C in the coastal plains to lower values in the hilly zones of the Nilgiris (CCCDM, 2024). The average minimum temperature is 22.6°C, with the lowest values recorded in the hilly districts. The hot summer period occurs from April to June, with temperatures rising up to 43°C, whereas the coolest winter period is between November and February, with temperatures around 18°C (CCCDM, 2024).

High-range districts in Kerala, such as Wayanad, also exhibits pronounced warming. Extreme maximum temperatures have exceeded 35°C in multiple years (2014, 2016, 2017, 2019, 2020, 2023), while minimum temperatures consistently surpassed 22.5°C, reflecting a narrowing diurnal temperature range that stresses shade-dependent crops and forest ecosystems (Sundaran et al., 2024; Kerala State Environment Department, 2022).

b) Dry spells and droughts: Recurrent droughts have become a major climate hazard, causing acute water scarcity and crop losses. Major drought years include 1980, 1987, 2002, 2016, 2020, 2021, and 2022, with the 2016 event reducing annual rainfall by 62% and causing economic losses (CCCDM, 2024). The region demonstrates a wet-drought dynamic, where high rainfall totals do not translate into usable water due to rapid runoff, soil degradation, and altered retention. In NWC, this is particularly pronounced: downstream areas in Kozhikode experience flash floods during high-intensity rainfall, followed by immediate water deficits. Forest fires are also a major and escalating manifestation of climate change in the corridor, driven by prolonged dry spells and rising temperatures (Stakeholder Consultation, 2025; CCCDM, 2024). In districts such as Wayanad, the convergence of severe drought and water scarcity has been directly linked to increased fire incidence (Kodandapani & Parks, 2019).

c) Precipitation and rainfall patterns: Rainfall in Tamil Nadu and Kerala is highly seasonal and spatially variable. Tamil Nadu depends primarily on the Northeast monsoon (October–December), which provides 48% of its annual rainfall, while the Southwest monsoon contributes 32% (CCCDM, 2024). While much of Kerala historically experienced declining rainfall, high-range districts like Wayanad and Idukki show increasing annual totals, whereas eastern districts of Tamil Nadu have seen reductions of up to 20% (Sundaran et al., 2024). Recent extreme events include Thoothukudi district receiving 900 mm in 24 hours in December 2023. The intensity of rainfall has increased while the number of rainy days has decreased, highlighting growing hydrological variability (CCCDM, 2024; Sundaran et al., 2024). In the NWC, extreme rainfall events have escalated, with cumulative increases of 4.68 mm (1979–2023) and 1.06 mm in 2013–2023 alone. Daily anomalies reached 14–22 mm in 2018, 2019, and 2021, triggering floods and landslides, with variability reaching 31% annually and 39% during the monsoon, the highest among analyzed Kerala districts (Sundaran et al., 2024). Despite increasing rainfall in the highlands, downstream plains continue to face flash floods and soil moisture deficits, reflecting the corridor's shrinking water-retention capacity. These increasingly intense and erratic rainfall events interact with the historical degradation of forest cover in the corridor, creating a compounded hazard scenario.

Current impacts: The observed shifts in climate across Tamil Nadu and Kerala are already producing tangible impacts on ecosystems, agriculture, water resources, and human settlements.

- **Agriculture and crop productivity:** In the Nilgiri–Wayanad Corridor (NWC), accelerated warming of night-time minimum temperatures relative to day-time maximums has altered flowering and fruiting cycles, particularly in shade-dependent crops such as coffee, tea, pepper, impacting yields (Anjitha, A.C., et al., 2024; Sundaran et al., 2024).

⁴ Climate Studio, Centre for Climate Change and Disaster Management, Anna University, Chennai

Extreme events, including floods and droughts, have already caused substantial losses in crop yields, while soil erosion, nutrient depletion, and pest outbreaks have been amplified by high-intensity rainfall events, further stressing agricultural productivity (Sundaran et al., 2024).

- **Hydrology and water resources:** Erratic rainfall combined with historical forest loss has led to increased runoff and flash floods in highland areas such as Wayanad and the Nilgiris, triggering landslides and slope destabilization (UNEP, 2025). The Chaliyar river basin faces acute freshwater deficits during non-monsoon periods threatening irrigation and drinking water for over 1.5 million residents (Environment Department, Kerala, 2025; UNEP, 2025). In response to recurrent drought conditions, water trucking for communities, livestock, and wildlife waterholes has been reported in stakeholder consultations, underscoring acute on-ground water stress in the NWC (Stakeholder Consultation, 2025). This wet-drought dynamic, where high rainfall does not translate into usable water due to rapid runoff and soil degradation, has already stressed rainfed agriculture and heightened forest fire incidence.
- **Ecosystems:** Montane forests and other highland ecosystems are experiencing thermal stress, altered phenology, and increased vulnerability due to warming temperatures and extreme precipitation events. Reduced forest cover in the corridor exacerbates soil instability, flash floods, and habitat fragmentation and facilitates the spread of invasive species due to degradation of native vegetation under combined climate and anthropogenic pressures (Sundaran et al., 2024; Kerala State Environment Department, 2022). The corridor has also experienced heightened cyclonic intensity over the last decade, causing widespread damage to infrastructure, settlements, and livelihoods (CCCDM, 2024).

e) Projected climate trends and impacts

Projected climate trends: Projected climate trends for Tamil Nadu and Kerala indicate a profound shift toward stochastic extremes, where rising temperatures and increased annual rainfall are accompanied by more frequent heatwaves, intense precipitation events, and severe hydrological imbalances (CCCDM, 2024; UNEP, 2025), which will intensify stress on ecosystems, agriculture, water systems, and vulnerable communities.

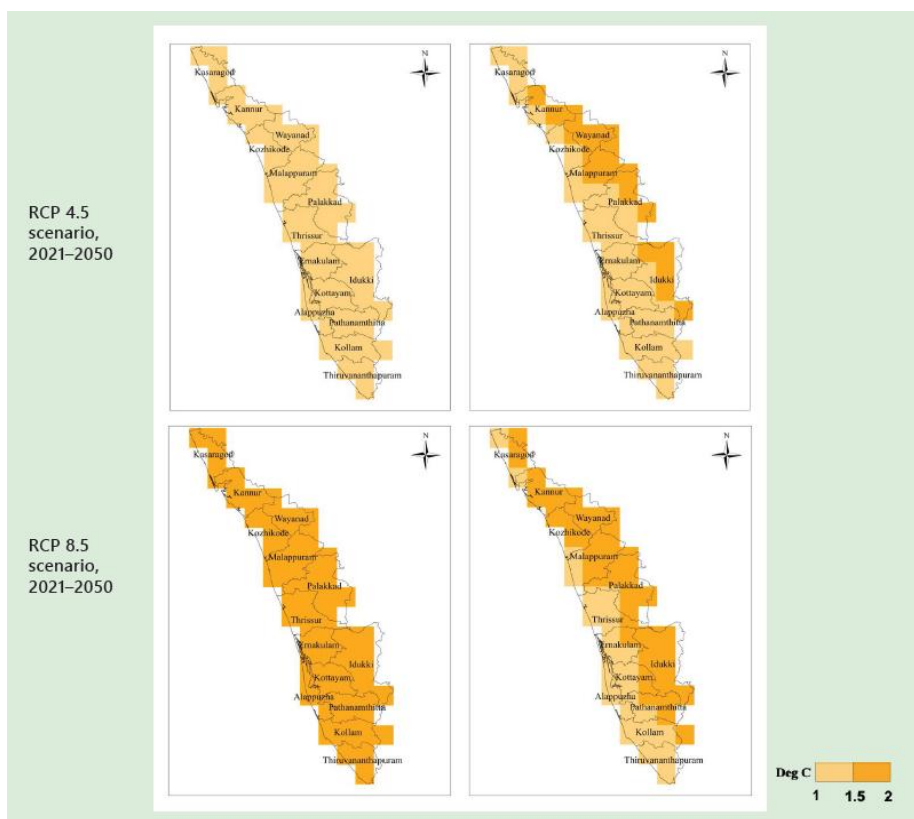


Figure 4⁵: Projected change in the summer maximum and winter minimum temperature (°C) during the near-term period under RCP 4.5 and RCP 8.5 scenarios in Kerala. The changes are calculated by subtracting the mean over 1990–2019 from the mean over 2021–2050.

- **Temperature and heat stress:** Both states are expected to experience significant warming throughout the 21st century. In Tamil Nadu, under the SSP5-8.5 (high-emission) scenario⁶, the annual mean maximum temperature is projected to

⁵ Kerala State Action Plan on Climate Change Report 2023-2030, Department of Environment, Govt. of Kerala

⁶ Shared Socioeconomic Pathways (SSPs) describe possible future societal and economic trends and, when combined with RCPs, help project climate impacts. SSP2-4.5 is a moderate, ‘middle-of-the-road’ scenario, while SSP5-8.5 assumes high emissions and fossil-fuel-driven growth [IPCC AR6, 2021].

rise by 0.6°C near-century, 1.7°C mid-century, and 3.5°C by the end of the century. Even under moderate emissions (SSP2-4.5), an increase of 1.7°C by 2100 is projected (CCCDDM, 2024). In the Nilgiris and Wayanad, night-time temperatures may rise by up to 3.9°C, significantly stressing shade-dependent crops such as coffee, pepper, and horticultural plantations (Sundaran et al., 2024; Kerala State Environment Department, 2022). Heatwave days are projected to increase dramatically, with the Nilgiris experiencing up to 55 days per year and Coimbatore 47–49 days per year by century-end, directly affecting crop productivity, forest ecosystems, and human health (CCCDDM, 2024; UNEP, 2025). Highland districts such as Wayanad and midstream areas are projected to experience compounded thermal and geomorphological impacts due to rising temperatures combined with altered rainfall patterns, further threatening biodiversity, water resources, and agricultural livelihoods (Kerala State Environment Department, 2022; Sundaran et al., 2024).

- **Dry spells and droughts:** Projected warming, combined with increasing rainfall variability, is expected to intensify meteorological droughts across both states. Inland and southern districts of Tamil Nadu may experience higher drought frequency and magnitude, potentially doubling the number of non-monsoon water stress events by the end of the century (CCCDDM, 2024). In Kerala, despite high rainfall in highland districts, a persistent wet-drought dynamic is projected, particularly affecting rainfed agriculture. Rapid runoff and declining water retention in the Chaliyar river basin are expected to produce a freshwater deficit of 214 MCM by 2040, threatening irrigation and drinking water supplies for over 1.5 million residents (Environment Department, Kerala, 2025; UNEP, 2025). Water scarcity is likely to compound livelihood stress, disproportionately affecting marginalized populations, including indigenous groups in Wayanad and midstream areas, who often travel long distances to access water.
- **Precipitation and rainfall patterns:** While total annual rainfall is projected to increase in several districts, rainfall intensity is expected to rise even as the number of rainy days declines, increasing hydrological variability (CCCDDM, 2024; Sundaran et al., 2024). In Tamil Nadu, projected rainfall increases range from 16% under SSP2-4.5 to 26% under SSP5-8.5 by century-end, with Coimbatore potentially seeing a 32.6% increase and the Nilgiris 19.4%. The NWC corridor is projected to experience high-intensity rainfall events exceeding 100 mm/day, increasing by roughly three additional events per year in Wayanad (Sundaran et al., 2024). By the end of the century, districts in Tamil Nadu are projected to experience 4–7 days per year of extreme rainfall (>64 mm/day), elevating the risk of floods and landslides (CCCDDM, 2024; Sundaran et al., 2024). In Kerala, future rainfall projections indicate intensification of flash floods and landslides, with 15.7% of the state's land area classified as flood-prone and 14.4% as landslide-prone, particularly in Wayanad and Kozhikode, identified as critical vulnerability hotspots (Kerala State Environment Department, 2022; UNEP, 2025). Despite high overall rainfall, the wet-drought phenomenon is projected to persist, particularly affecting rainfed agriculture and exacerbating water scarcity, crop vulnerability, and ecosystem stress.

Projected impacts: Future climate changes in the NWC are expected to intensify and compound existing risks across agriculture, water systems, ecosystems, and livelihoods (CCCDDM, 2024; Sundaran et al., 2024; UNEP, 2025).

- **Agriculture and crop productivity:** Key plantation crops such as coffee, tea, pepper, and cardamom are projected to lose 15–25% of suitable cultivation area in high-elevation zones where warming may exceed crop tolerance thresholds (Sundaran et al., 2024). Elevated night-time temperatures are likely to disrupt flowering synchrony, reduce grain filling and fruit set, and increase pest and fungal infestations by 30–40%, reducing both yield and quality (Kerala State Environment Department, 2022; Sundaran et al., 2024). Coffee, tea, pepper, cardamom, and coconut are projected to face 20–50% yield losses under extreme events (CCCDDM, 2024). Soil erosion, nutrient leaching, and slope instability are projected to increase under more intense rainfall events, weakening long-term soil productivity (CCCDDM, 2024). These combined pressures are expected to compel farmers to diversify crops, relocate cultivation to lower-risk zones, or exit climate-sensitive plantation systems (UNEP, 2025).
- **Hydrology and water security:** Despite projected increases in annual rainfall, seasonal imbalances are expected to worsen. Freshwater deficits in the Chaliyar river basin may reach 214 MCM by 2040 due to rapid runoff, declining infiltration, and reduced groundwater recharge (Environment Department, Kerala, 2025; UNEP, 2025). Groundwater levels in midstream districts such as Coimbatore are projected to decline by 15–20%, increasing competition among domestic, agricultural, and industrial users (UNEP, 2025). More frequent high-intensity rainfall events are expected to increase flood damage to irrigation systems, roads, and settlements, creating dual drought–flood risks within the same hydrological year (Kerala State Environment Department, 2022; Sundaran et al., 2024).
- **Ecosystems:** Vegetation shifts are projected in highlands, with evergreen forest cover in the Nilgiris expected to decline by 17% and deciduous forests by 11% by 2050, while thorn and scrub vegetation may expand by up to 60% (Kerala State Environment Department, 2022). Habitat suitability for evergreen and deciduous forests in Tamil Nadu may decrease by 17–32% and 11–31%, respectively (CCCDDM, 2025). These changes are likely to fragment habitats, alter species composition, and increase human–wildlife conflict by 20–25% as elephants, tigers, and wild boars increasingly

enter farmland and settlements (Sundaran et al., 2024). Riparian systems along the Chaliyar River are expected to experience intensified erosion and sedimentation, destabilizing freshwater supply systems (UNEP, 2025).

- **Landslides and slope instability:** Landslide risk in the NWC is projected to increase due to more frequent high-intensity rainfall (about three additional >100 mm/day events annually in Wayanad by century-end) interacting with degraded forest cover (Sundaran et al., 2024). With Wayanad's forest cover reduced by 62% since 1950, slope stability has significantly weakened (Kerala State Environment Department, 2022). The 2024 Wayanad landslide disaster, causing over 400 deaths and large-scale displacement, highlights the severity of this risk (UNEP, 2025). Future projections indicate more frequent mass movements in Wayanad and the Nilgiris, with cascading impacts on infrastructure, agriculture, and downstream flood and siltation risks in Kozhikode. (CCCCDM, 2024; Sundaran et al., 2024).

f) Climate Vulnerabilities

The Nilgiri–Wayanad Corridor (NWC) exhibits high socio-economic and ecological sensitivity due to the predominance of smallholder and forest-dependent livelihoods. Average landholdings range from 1 to 1.5 hectares, with over 70% of cultivation rainfed and reliant on limited irrigation infrastructure, constraining resilience to environmental shocks (Sundaran et al., 2024). Household incomes are low and irregular, sourced primarily from subsistence agriculture, forest products, and casual labor, limiting capacity to invest in long-term adaptive measures (Kerala State Environment Department, 2022).

- **Exposure to climate hazards:** Settlements across the corridor are exposed to multiple, compounding hazards. Hill communities in the Nilgiris and Wayanad face landslides and slope failures due to extreme rainfall, as observed during the 2024 Chaliyar basin landslides (Environment Department, Kerala, 2025). Rising daytime and night-time temperatures will intensify heat stress for residents and agricultural workers (CCCCDM, 2024; Sundaran et al., 2024). As mean annual temperatures are projected to rise 1.5–2.0°C, night-time temperatures by up to 3.9°C, and heatwave days may reach 47–55 per year (CCCCDM, 2024; UNEP, 2025) this will further intensify impacts on local communities. Short-duration, high-intensity rainfall events are projected to increase, elevating flash flood and landslide risks downstream (Sundaran et al., 2024).
- **Sensitivity of settlements and livelihoods:** Ecological degradation and socio-demographic factors are projected to amplify settlement sensitivity. Human settlements are highly sensitive due to social vulnerabilities. Tribal groups, including the Cholanaiikka, Paniya, and Kattunayaka, are highly vulnerable due to dependence on forest resources for food, fuel, and supplementary income. Limited land tenure, low literacy, and restricted access to markets constrain livelihood diversification and reduce coping capacity. Social marginalization further restricts access to government support, agricultural extension, and financial services (Sundaran et al., 2024; UNEP, 2025). Women are projected to spend additional hours on water collection and livestock care during heatwaves and droughts, while the elderly, children, and persons with disabilities face mobility and health constraints during floods, landslides, and extreme heat events (Sundaran et al., 2024; UNEP, 2025). Access to water, energy, healthcare, roads, and markets is uneven, limiting resilience and adaptive options for households (Environment Department, Kerala, 2025).
- **Adaptive capacity constraints:** Adaptive capacity across the corridor remains low due to economic, institutional, and infrastructural limitations. Many smallholders earn modest incomes, leaving little buffer for adaptation investments (Kerala State Environment Department, 2022). Fragmented governance across state boundaries limits integrated landscape-level planning, disaster preparedness, and coordinated response strategies (UNEP, 2025). Limited irrigation coverage and water storage infrastructure are projected to constrain responses to drought and flood events (Environment Department, Kerala, 2025). Intensified climate hazards are expected to further stress adaptive capacity, making proactive interventions critical (CCCCDM, 2024; UNEP, 2025).

Gendered vulnerabilities: Women, particularly from indigenous and smallholder households, face multidimensional vulnerabilities from economic marginalization, social barriers, and environmental stress. They bear primary responsibility for domestic water collection, often traveling 2–3 km daily; during dry spells, this can extend by 2–3 hours, contributing to physical strain and “time poverty,” reducing rest and income opportunities (Stakeholder consultations, 2025). Girls are often pulled into water collection, leading to interrupted schooling and limiting future adaptive capacity. Women also manage household care during health crises, including waterborne diseases and heat-related illness, compounding unpaid labor burdens (Stakeholder consultations, 2025). Women lack ownership of productive assets such as land, limiting access to credit, crop insurance, and compensation for wildlife-related crop damage (Stakeholder consultations, 2025). They play a central role in cultivating subsistence crops, particularly millets, managing seed selection, cultivation, and storage; declining yields threaten household food security, especially in female-headed households. Limited access to training, agricultural extension, and participation in local governance further reduces their adaptive capacity (Government of Kerala, State Planning Board, 2025; Stakeholder consultations, 2025).

The NWC's vulnerabilities stem from the interplay of small landholdings, rainfed agriculture and forest dependence, low income, social marginalization, gender inequities, limited infrastructure, and weak institutional support. These structural

factors define current sensitivity and constrain adaptive capacity, highlighting the need for targeted interventions to strengthen livelihoods, improve resource access, and support gender-equitable adaptation (Sundaran et al., 2024; UNEP, 2025). District level vulnerabilities are provided in the table below.

Table 1: District level vulnerabilities across NWC

District	Zone in NWC	Degree of vulnerability	Total Population	Female Population	Indigenous Population
Nilgiris (Tamil Nadu)	Core intervention landscape (upper montane catchment)	The Nilgiris is highly vulnerable because of its steep terrain and dependence on tea and vegetable cultivation. Fragmented landholdings and tourism-driven land conversion increase slope instability, forest fragmentation, and ecosystem degradation, directly affecting upper catchment stability and hydrological regulation. Montane species such as the Nilgiri tahr are losing habitat due to warming temperatures and fragmentation, increasing ecological sensitivity. The primary adaptation need is restoring montane forests and shola–grasslands, managing invasive species, rehabilitating spring-sheds, and reducing landslide and flood risks to stabilise upstream hydrology.	735,394 (Census of India, 2011)	372,948 (50.7%)	approx. 105,062 (approx. 14.3% ST, Census of India, 2011)
Wayanad (Kerala)	Core intervention landscape (upper montane catchment)	Wayanad is highly vulnerable due to its dependence on coffee and black pepper cultivation, where floods and erratic rainfall can cause yield losses of 20–50%. Nearly 70% of agricultural land is rainfed, increasing sensitivity to rainfall variability and drought. The district has a large indigenous groups population with lower literacy levels and high reliance on public support, limiting adaptive capacity. Forest fragmentation, soil erosion, and pressure on elephant corridors exacerbate ecological degradation and weaken catchment integrity, affecting downstream hydrological flows. The primary adaptation need is restoring upper catchment integrity, forests, slopes, and spring-sheds to stabilise hydrology, reduce disaster risk, and protect downstream flows into the Chaliyar and Kabani river systems.	817,420 (Census of India, 2011)	415,736 (50.9%)	approx. 157,780 (approx. 19.3% ST, Census of India, 2011)
Coimbatore (Tamil Nadu)	Hydrologically linked secondary zone (midstream)	Coimbatore is vulnerable due to increasing hydrological stress linked to upstream catchment degradation and local land-use pressures. Limited green cover and water storage reduce resilience to rising temperatures and water variability, while industrial and urban heat-island effects compound stress on water resources. Agricultural areas face moderate vulnerability due to temperature and rainfall variability, affecting crop performance. These factors, combined with altered upstream flows, contribute to water insecurity and compound drought–flood risks. The primary adaptation need is strengthening downstream watershed management, improving water storage and governance, and	3,458,045 (Census of India, 2011)	1,729,025 (50.0%)	approx. 69,161 (approx. 2.0% ST, Census of India, 2011)

		enhancing resilience to basin-wide hydrological variability and climate extremes.			
Kozhikode (Kerala)	Hydrologically linked secondary zone (midstream / downstream benefit zone)	Within the project geography, the relevant part of Kozhikode district is its eastern highland and midstream river valley areas along the Chaliyar basin, which are hydrologically linked to the NWC core catchments. These areas face high vulnerability due to upstream catchment degradation, resulting in increased sedimentation, flash flood risk, and slope instability. Poor irrigation coverage and limited groundwater availability constrain the ability of local communities to cope with water stress, while ecosystem degradation further affects basin stability. The primary adaptation need is strengthening watershed governance, restoring riparian systems along Chaliyar tributaries, and improving institutional capacity to manage basin-wide water variability and hydrological risks.	3,086,293 (Census of India, 2011)	1,615,351 (52.3%)	approx. 18,500 (approx. 0.6% ST, Census of India, 2011)

g) Problem Statement

NWC is experiencing a compounding climate and ecological crisis that is systematically eroding the resilience of its communities and ecosystems. The corridor functions as the hydrological water tower of peninsular southern India, providing headwaters for the Bhavani, Chaliyar, Kabani, and Moyar river systems that sustain over 1.5 million people downstream. This critical function is being undermined by the intersection of long-term ecological degradation and intensifying climate change, a dynamic that existing fragmented efforts have been unable to reverse at landscape scale. **The central adaptation problem is that the NWC's communities, particularly Indigenous Peoples, women, and forest-dependent smallholders, are increasingly exposed to climate hazards they can neither anticipate nor withstand, because the natural systems that once buffered them have been degraded, the institutions meant to protect them lack capacity, and the information and finance needed to adapt are largely inaccessible. The following direct threats, indirect causes, and root causes define this problem.**

- Escalating climate hazards (Critical project priority):** Climate change is directly intensifying hazard risk across the NWC. Extreme weather events have increased five-fold over five decades (EDGK, 2025). High intensity rainfall events are interacting with severely degraded forest cover to elevate slope failure risk across the corridor. Wayanad and the Nilgiris are among the highest landslide risk districts in their respective states, with mass movement events causing cascading consequences for settlements, agriculture, road connectivity, downstream reservoir siltation, and flood risk in Kozhikode and Malappuram (CCCDM, 2024; Kerala State Environment Department, 2022). Early warning systems are largely absent across the corridor, particularly in remote Indigenous settlements, leaving communities without the anticipatory warning capacity needed to protect lives before slope failures occur (Stakeholder Consultations, 2025). Rising temperatures are altering the flowering and fruiting cycles of shade-dependent plantation crops, coffee, tea, pepper, and cardamom, on which the majority of corridor smallholders depend, driving yield decline and increasing pest and disease pressure (CCCDM, 2024). Prolonged dry spells are intensifying water scarcity, expanding invasive species cover, and increasing forest fire frequency, compounding the ecosystem and water security threats described above
- Ecosystem degradation and loss of natural buffers (Critical project priority):** Long-term forest loss, conversion to monoculture plantations, invasive species proliferation, habitat fragmentation, and unregulated infrastructure development have severely weakened the NWC's ecological resilience and eliminated its capacity to buffer communities against climate shocks. Forest cover in Wayanad has declined by 62% since 1950 and by 35.3% across the broader corridor over the past century (Sri et al., 2021; Kerala State Environment Department, 2022). This loss has been driven by agricultural encroachment and land tenure insecurity that have pushed smallholders to convert natural forests to monoculture tea, coffee, and rubber plantations, reducing soil binding capacity, structural diversity, and water retention. Unregulated development such as road construction on slopes steeper than 22 degrees and extensive quarrying, has further destabilised thin soils across steep terrain (MoEFCC, 2013). Habitat fragmentation, a direct consequence of forest conversion and infrastructure expansion, has severed key wildlife movement zones including the Naikatty–

Ponkuzhi–Mulehole elephant corridors in Wayanad, displacing wildlife into agricultural areas and intensifying human–wildlife conflict across forest-adjacent communities (Menon, 2023). Climate change is actively exacerbating ecosystem degradation: prolonged dry spells and rising temperatures are expanding invasive species, particularly *Lantana camara* and *Senna spectabilis*, into areas vacated by native vegetation, suppressing natural regeneration, increasing flammable dry biomass accumulation, and further weakening slope stability and groundwater infiltration (Anoop and Ganesh, 2020). Scaling up the systematic removal of invasive *Lantana camara* and *Senna spectabilis* is therefore a core hydrological recovery strategy to restore the natural forest sponge effect, rebuilding soil infiltration capacity and reducing surface runoff velocity across degraded slopes. Forest fires, driven by dry spells and invasive biomass build-up, are becoming more frequent and severe across Wayanad and the Nilgiris, contributing to accelerated forest dieback, habitat loss, and further degradation of ecosystem services (Kodandapani and Parks, 2019; Stakeholder Consultations, 2025). Stakeholder consultations confirmed that invasive species proliferation directly undermines both biodiversity and livelihood security, and that current restoration efforts remain too fragmented to counter these dynamics at corridor scale. The consequences are cascading and severe. Degraded slopes stripped of root systems and forest litter cannot absorb monsoon rainfall, increasing surface runoff velocity and triggering catastrophic landslides and flash floods, as demonstrated by the 2024 Wayanad tragedy, which caused over 400 fatalities and displaced thousands (UNEP, 2025). Biodiversity is at acute risk, with evergreen forests in the Nilgiris and Coimbatore projected to decline by a further 32% by 2050 as more arid vegetation types expand (Kerala State Environment Department, 2022). Human–wildlife conflict is intensifying, causing escalating crop losses, injuries, and livelihood insecurity for forest-adjacent communities throughout the corridor.

- **Hydrological stress and water scarcity (Critical project priority):** The collapse of the NWC's water retention and groundwater recharge capacity, driven by forest loss, catchment degradation, soil erosion, and intensifying rainfall variability, has produced a severe and worsening water security crisis. Soil erosion, top soil loss, declining fertility, and disrupted hydrological cycles are compromising agricultural productivity and threatening water access across the corridor. Intense rainfall over degraded land, poor land management, and invasive species colonization have together reduced infiltration capacity and increased surface runoff, accelerating the depletion of springs and groundwater sources. The corridor exhibits a persistent wet–drought dynamic: high-intensity monsoon rainfall fails to translate into usable water due to rapid runoff over degraded soils, while non-monsoon periods are characterized by acute freshwater deficits. Deploying decentralised rainwater harvesting systems, percolation pits, and soil-moisture monitoring tools in rainfed smallholder areas is therefore a critical measure to capture monsoon runoff before it escapes degraded slopes and reduce seasonal water deficits. High-resolution hydrogeological mapping of these drying traditional springs across the upper montane forested catchments of Wayanad and the Nilgiris plateau is therefore a critical precondition for targeted catchment treatment and recharge zone protection, particularly to preserve the headwaters of the vital Bhavani, Chaliyar, and Kabani river systems. In Wayanad, over 70% of agriculture is rainfed and dependent on seasonal springs, many of which are drying earlier each year (DoECC, 2022). Stakeholder consultations documented water trucking to communities, livestock, and wildlife waterholes during drought, a direct indicator of current acute water stress. Women bear the greatest burden of this crisis: they travel 2–3 km daily for water collection, extending by 2–3 additional hours during droughts, directly reducing time available for productive activity and worsening household food insecurity (Stakeholder Consultations, 2025). Water security is addressed in this project as a dedicated climate adaptation investment, not a co benefit. Hydrological recovery and forest recovery are treated as inseparable objectives.

Indirect causes:

- **Constrained adaptive capacity of smallholder farmers:** Smallholders in the NWC cultivate average plots of 1–1.5 ha with low and irregular incomes, severely restricting investment in soil conservation, crop diversification, and climate-resilient inputs (Sundaran et al., 2024). Indigenous communities, including the Paniya, Kattunayaka, Adiya, Cholanaiikka, Toda, Kota, Badaga, Kurumba, and Irula, face insecure land tenure and restricted access to government support, extension services, and formal financial systems, limiting their capacity to invest in adaptation (UNEP, 2025; Census of India, 2011). Women, despite shouldering the greatest climate burden, lack land ownership and compensation eligibility, and have limited voice in local governance and planning processes (Stakeholder Consultations, 2025; Government of Kerala, State Planning Board, 2025). Youth out-migration has left an ageing and feminised rural workforce with reduced labour availability for sustainable land management.
- **Weak access to climate information, finance, and risk transfer tools:** Localised climate information, advisory services, extension support, and risk financing instruments are largely inaccessible to communities and local institutions across the NWC. Awareness and uptake of crop insurance and parametric risk transfer instruments are very low. The absence of weather stations in key NWC highland zones reduces the capacity of communities and local agencies to track and respond to rainfall and temperature extremes. Financial barriers including limited collateral and restricted formal credit access, prevent households and Local Self-Governments from investing in adaptive practices and resilient infrastructure.

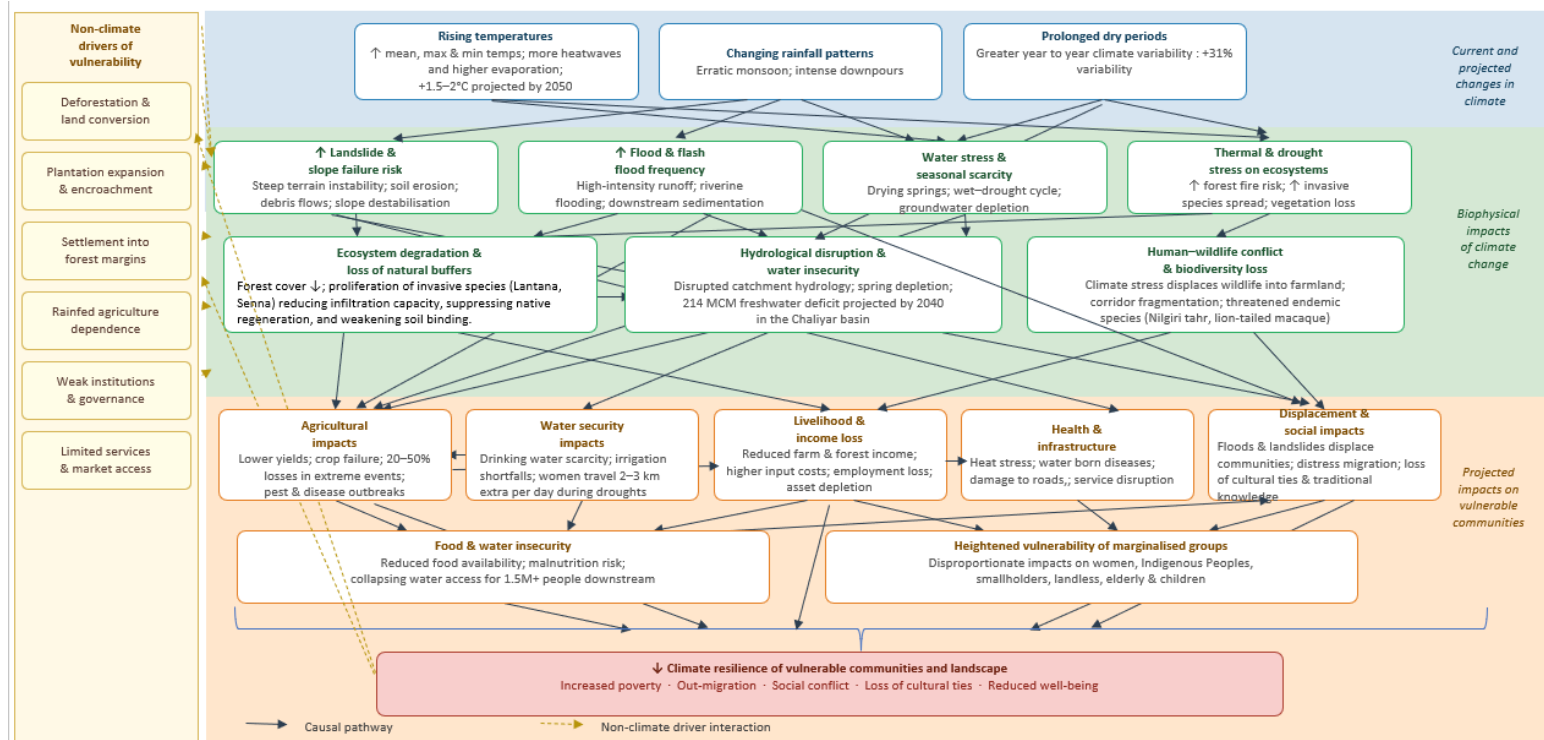
- **Institutional fragmentation and limited convergence:** There is fragmented intervention across departments and schemes, with limited cross-sectoral convergence between forestry, agriculture, water, disaster management, and rural development agencies. Adaptation actions are often project-based and not integrated at the landscape level. Local governments and community institutions face capacity gaps in planning, implementing, and using available climate and disaster funds. Coordination gaps and weak last-mile delivery reduce the effectiveness and scalability of adaptation measures. Stakeholder consultations emphasized the need for stronger cross-departmental coordination and technical support to ensure effective implementation.
- **Gaps in community capacity, skills, and technical support:** Communities and frontline institutions lack adequate training and technical support in climate-resilient agriculture, soil and water conservation, ecosystem restoration, invasive species management, and biodiversity-linked livelihoods. Traditional and indigenous knowledge systems are eroding because they are not systematically integrated into formal adaptation planning. Capacity barriers limit the adoption of proven, field-tested adaptation practices. Stakeholders highlighted the importance of integrating indigenous knowledge and women's leadership into adaptation interventions.

Root causes of the problem: The major root causes driving environmental degradation, biodiversity loss, and socio-ecological vulnerability in the NWC stem from interconnected social, economic, and historical factors.

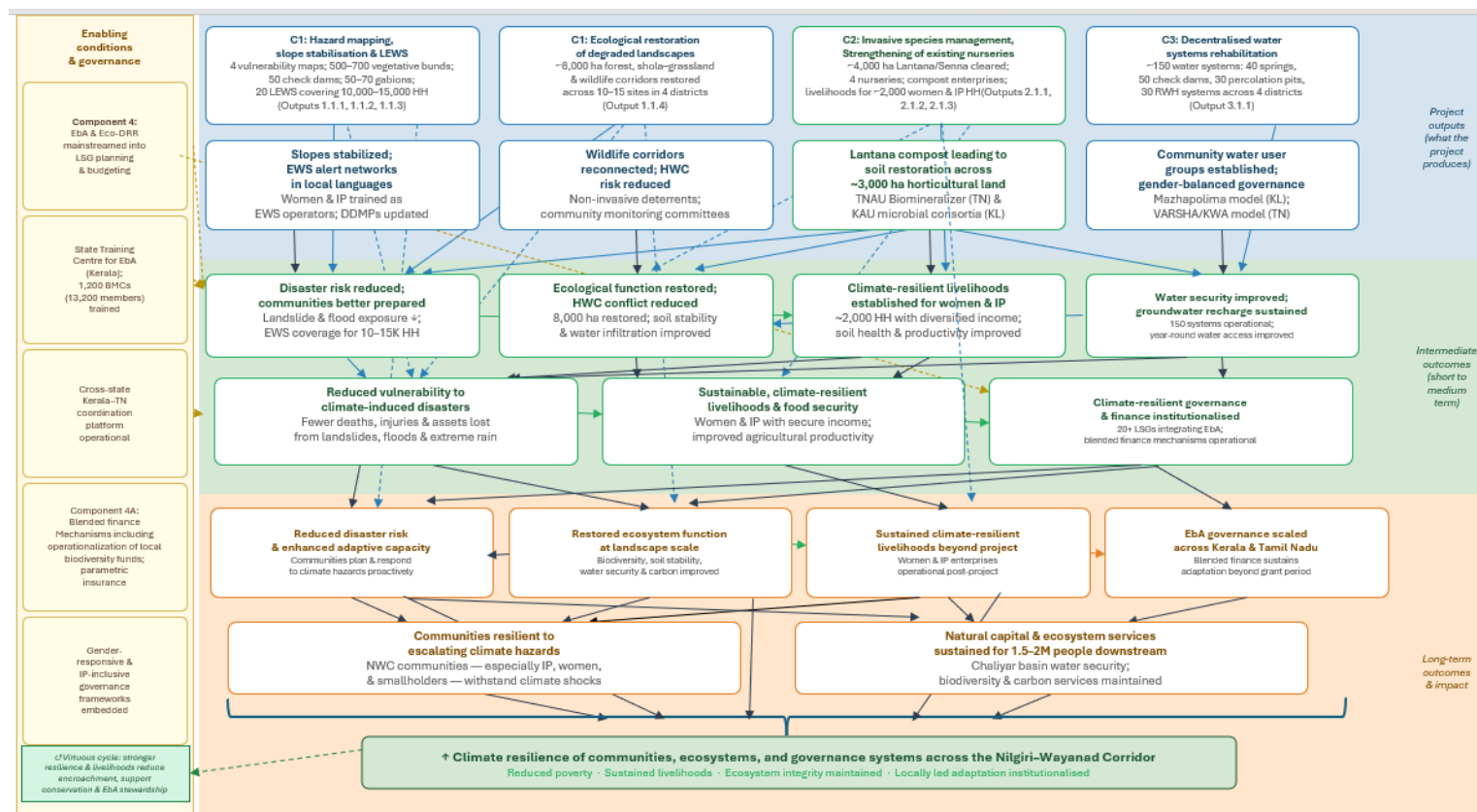
- **Economic and market drivers:** Market incentives favouring short-term profits from cash crops, plantation expansion, and construction have shifted land use from conservation to extraction across the corridor, destabilising soils, fragmenting habitats, and intensifying pressure on natural resources. Economic development pressures continue to drive encroachment on forested slopes and ecologically sensitive catchments.
- **Demographic and social pressures:** High population density across the Chaliyar Basin amplifies pressure on land, water, and forests. Settlements expanding into forest fringes and hazard-prone slopes are increasing communities' direct exposure to floods, landslides, and human–wildlife conflict. Youth out-migration has concentrated an ageing and feminised workforce in rural areas, reducing labour availability for sustainable land management and increasing reliance on low-diversity, high-risk monoculture systems.
- **Poverty and livelihood fragility:** Rural poverty across the NWC is pervasive and structural. Dependence on climate-sensitive rainfed crops like coffee, tea, pepper, cardamom, and coconut, exposes farmers directly to monsoon variability, drought, flooding, and heat stress. Limited access to irrigation, credit, technical knowledge, and insurance traps households in cycles of debt that restrict adaptive investment. Women's lack of land ownership restricts access to insurance and compensation. Indigenous communities' tenure insecurity limits livelihood diversification and recovery capacity following climate shocks.
- **Historical landscape transformation:** Decades of anthropogenic pressure have converted native tropical wet evergreen forests and montane shola–grassland systems into monoculture plantations of coffee, tea, pepper, rubber, and eucalyptus. This historical transformation has weakened the landscape's natural buffering capacity, disrupted hydrological cycles, fragmented wildlife corridors, and increased the vulnerability of endemic species and dependent communities to climate extremes.
- **Structural inequality and tenure insecurity:** Indigenous communities, including the Cholanaikka, Kattunayaka, and Paniya, face systemic marginalisation and insecure land tenure. Delays in land rights recognition, restricted access to forest resources, and limited participation in governance processes erode traditional ecological stewardship and reduce the capacity of Indigenous households for resilient land and forest management.
- **Gender and social inequalities:** Women disproportionately shoulder unpaid care and labor responsibilities, such as spending long hours collecting water, while having limited decision-making power within households and communities. These social inequities reduce adaptive capacity and compound vulnerability to climatic and ecological shocks. Stakeholder consultations reinforced that interventions must prioritize women, marginalized farmers, and indigenous groups households to address these systemic inequalities and strengthen community resilience.

Stakeholder consultations conducted between January and February 2026 directly informed the project's design, priorities, and proposed interventions. Key findings highlighted urgent needs to improve landslide and flood risk management, restore degraded ecosystems, enhance water security, and diversify climate-resilient livelihoods, particularly for smallholders, women, and Indigenous communities. Gaps identified in early warning systems, access to climate information, and cross-sector coordination led to the inclusion of localized early warning systems, climate advisory services, and integrated landscape governance mechanisms. Stakeholders also emphasized the importance of ecosystem restoration, including invasive species management, human–wildlife conflict mitigation, and gender-responsive, inclusive approaches. These consultations shaped the project's focus on ecosystem-based adaptation, decentralized water management, community led restoration, and capacity building, ensuring that interventions are locally relevant, inclusive, and demand-driven.

Problem Tree



Solution Tree



Based on the background problem analysis and stakeholder consultations, the Table below presents the project's climate risk analysis, mapping key climate hazards to their associated risks, selected risk management measures, and expected results.

Table 2: Climate Risk Analysis

	Climate hazard and associated risks	Selected risk management measures by project	Component / Output	Expected result	Residual risk / assumptions
1	Extreme rainfall triggering landslides and slope failures in steep mountainous terrain	Composite vulnerability mapping integrating hazard and social data; slope bioengineering (500–700 vegetative bunds, contour trenches, 50 check dams, 50–70 gabion walls, 200–300 recharge pits); 20 community-level localised early warning systems (LEWS) aligned with IMD/NLFC protocols	C1 / Output 1.1.1, Output 1.1.2, Output 1.1.3	4 district-level vulnerability maps embedded into 20 GDPDs and 4 DDMPs; slopes stabilized in 2 montane districts (Nilgiris and Wayanad); 10,000–15,000 households covered by LEWS; reduced loss of life and livelihoods from landslides	Extreme events may exceed design thresholds; residual risk remains in highly unstable slopes
2	Rainfall variability and seasonal hydrological imbalance causing water insecurity despite high monsoon rainfall	High resolution hydrogeological mapping of drying traditional springs across upper montane forested catchments of Wayanad and the Nilgiris plateau; Spring-shed mapping and rehabilitation; approximately 150 decentralised water systems, 40 priority springs, 50 check dams, 30 percolation pits, 30 rainwater harvesting systems, using Mazhapolima model (Kerala) and VARSHA/KWA model (Tamil Nadu); community water user groups with gender-balanced governance and IP representation; decentralised rainwater harvesting storage networks, percolation pits, and soil-moisture monitoring tools in rainfed smallholder farming areas to capture high velocity monsoon runoff before it escapes degraded slopes.	C3 / Output 3.1.1	Groundwater recharge improved; spring flows sustained; year-round water availability strengthened across Wayanad and Kozhikode (Kerala) and Nilgiris and Coimbatore (Tamil Nadu)	Prolonged droughts or shifting rainfall patterns may limit recharge effectiveness in some locations
3	High-intensity rainfall causing flash floods, rapid surface runoff, and downstream sedimentation	Watershed restoration; contour bunding; vegetative buffers; nature-based sediment and runoff management to enhance infiltration and reduce peak flows; invasive species removal restoring soil infiltration capacity and reducing surface runoff; nature-based solutions including vetiver grass, hedgerows, contour trenches, and check dams in midstream valleys and riparian zones of the Chaliyar and Bhavani tributaries to improve aquifer recharge and stabilise slopes	C1 / Output 1.1.2; C2 / Output 2.1.2	Runoff and sedimentation reduced; catchment stability improved; downstream flood risk and infrastructure damage decreased	Severe extreme events may still generate downstream flooding beyond managed capacity
4	Rising temperatures and prolonged dry spells increasing ecosystem stress, forest fire risk, and invasive species spread	Removal of approximately 4,000 ha of <i>Lantana camara</i> and <i>Senna spectabilis</i> as a core climate adaptation measure; TNAU Biomineralizer (Tamil Nadu) and KAU microbial consortia (Kerala) converting Lantana biomass into organic compost channelled into soil restoration across approximately	C2 / Output 2.1.2	Invasive species controlled across approximately 4,000 ha; native vegetation restored; fire and erosion risks reduced; approximately 20 composting enterprises generating livelihood	Re-invasion risk persists without sustained management; climate conditions may favour regrowth of invasives

		3,000 ha of horticultural landscapes; assisted natural regeneration of native species		income for women and IP community members	
5	Climate-induced ecosystem shifts increasing human–wildlife conflict in fragmented forest–agriculture interfaces	Ecological restoration of approximately 8,000 ha of degraded forest, shola–grassland, and wildlife corridor habitats across 10–15 landscape sites; corridor restoration; wildlife-friendly land-use planning; buffer zone management; non-invasive deterrents (solar fencing, bee fences, chili barriers); community wildlife monitoring committees with IP and women participation	C1 / Output 1.1.4	Approximately 8,000 ha restored across 10–15 sites in 4 target districts; wildlife corridors strengthened; habitat connectivity improved; crop losses reduced and coexistence improved	Wildlife movement patterns may continue shifting under climate change, maintaining some residual conflict
6	Heat stress and erratic rainfall reducing agricultural productivity and increasing livelihood vulnerability	Agroforestry systems; crop diversification towards millets and mixed systems; NTFP value chains; at least 4 nurseries (including native and non-invasive commercial species), one per district, managed by women and IP communities; Lantana composting enterprises; organic farming, composting, and mulching across approximately 3,000 ha of horticultural landscapes	C2 / Output 2.1.1, Output 2.1.2, Output 2.1.3	Land-based livelihood training and equipment support for approx. 2,000 women and IP households; diversified climate-resilient income sources; improved soil health and productivity; reduced income variability for smallholders, women, and IP communities	Market fluctuations and extreme climate shocks may still affect income stability
7	Increasing frequency and intensity of climate shocks with limited access to climate finance and risk transfer mechanisms	At least 2 blended finance mechanisms (NAFCC, GEF, GCF, CSR, multilateral banks); parametric risk transfer instruments linked to rainfall/landslide thresholds; crop and livestock insurance for at least 500 women-headed and IP households; local biodiversity funds providing grants and loans without land collateral requirements	C4 (4A) / Output 4.2.1, Output 4.2.2	Finance-ready adaptation pipeline operational; existing local biodiversity funds leveraged within blended finance architecture; parametric insurance instruments piloted; at least 500 women-headed and IP households covered by risk financing	Uptake of financial instruments may remain gradual; affordability and awareness constraints may persist
8	Complex and evolving climate risks requiring strengthened local governance, coordination, and institutional adaptive capacity	Mainstreaming EbA and Eco-DRR into LSG planning and budgeting; 1 State Training Centre for EbA established in Kerala; training of 1,200 BMCs (13,200 members) across Kerala and Tamil Nadu; at least 3 cross-district and cross-state peer learning workshops; at least 20 LSGs integrating EbA into annual budgets; digital adaptation platforms with confirmed post-project State Government ownership	C4 / Output 4.1.1, Output 4.1.2	Climate risk reduction institutionalized in local governance systems; 13,200 BMC members trained; at least 20 LSGs with EbA in budgets and plans; sustained cross-state Kerala–Tamil Nadu coordination with confirmed post-project ownership	Institutional capacity may vary across locations; sustained political and administrative support required post-project

II. Project/Programme Objectives

The programme's primary objective is to reduce climate vulnerability and strengthen the resilience of communities, ecosystems, and local governance systems in the Nilgiri–Wayanad Corridor through integrated, landscape-scale climate adaptation investments that address landslide risks, hydrological instability, ecosystem degradation, invasive species impacts, and climate-sensitive livelihood vulnerabilities. Climate adaptation is the primary objective of all project

components. Mitigation-related outcomes, including carbon sequestration resulting from ecosystem restoration, will be treated strictly as secondary co-benefits.

Outcome 1.1: Reduced loss of life, livelihoods, and assets from landslides, extreme rainfall, and flash floods in the most acutely exposed settlements and catchments of the NWC, through green-grey solutions and disaster preparedness.

Increasing climate variability and land degradation have intensified landslide risks and hydrological instability across the corridor. Component 1 will produce 4 district-level composite vulnerability maps embedded into at least 20 Gram Panchayat Development Plans and 4 District Disaster Management Plans (Output 1.1.1); construct approximately 500–700 vegetative bunds, 50 check dams, 50–70 gabion walls, and 200–300 recharge pits to stabilise landslide-prone slopes in 2 montane districts (Output 1.1.2); deploy 20 community-level localised early warning systems covering 10,000–15,000 households across 4 target districts (Output 1.1.3); and ecologically restore approximately 8,000 ha of degraded forest, shola–grassland, and wildlife corridor habitats across 10–15 landscape sites (Output 1.1.4). These actions will reduce disaster exposure and improve resilience among vulnerable communities, particularly women and Indigenous Peoples.

- **Outcome 2.1:** Women and Indigenous Peoples households across 4 target districts derive sustainable climate-resilient livelihoods from ecosystem restoration investments

Invasive species spread under intensifying drought and heat stress is reducing ecosystem resilience, degrading soil health, and increasing livelihood risks. Component 2 will strengthen at least 4 nurseries (including native and non-invasive commercial species), one per target district, managed by Indigenous Peoples and women as community enterprises (Output 2.1.1); systematically remove approximately 4,000 ha of *Lantana camara* and *Senna spectabilis* and convert invasive biomass into productive organic compost via TNAU Biomineralizer (Tamil Nadu) and KAU microbial consortia (Kerala), channeled into soil restoration across approximately 3,000 ha of horticultural landscapes (Output 2.1.2); and provide land-based livelihood training and equipment support to approx. 2,000 women and IPs households through *Lantana* composting enterprises, nursery operations, NTFP value chains, and agroforestry (Output 2.1.3). Women and Indigenous Peoples will participate actively in enterprise management, restoration planning, and benefit-sharing.

- **Outcome 3.1:** Reduced household water insecurity through green-grey interventions to address intensifying dry spells, groundwater depletion, and seasonal hydrological disruption.

Intensifying hydro-climatic shifts, including reduced baseflows, groundwater decline, and erratic seasonal water availability, are threatening domestic and agricultural water security across the corridor. Component 3 will rehabilitate approximately 150 decentralized water systems across 4 target districts, comprising 40 priority springs, 50 check dams, 30 percolation pits, and 30 rainwater harvesting systems (Mazhapolima model in Kerala; VARSHA/KWA model in Tamil Nadu), with community water user groups established with gender-balanced governance and Indigenous Peoples representation to ensure equitable access and post-project sustainability (Output 3.1.1).

- **Outcome 4.1:** Local self-governments effectively plan, finance, and implement climate-resilient and biodiversity-positive actions through gender-responsive and Indigenous Peoples-inclusive governance systems across Kerala and Tamil Nadu.

Limited institutional capacity and fragmented planning systems constrain locally led climate adaptation. Component 4 will establish 1 State Training Centre for EbA in Kerala and train 13,200 members across 1,200 Biodiversity Management Committees in climate-resilient EbA planning across Kerala and Tamil Nadu, with EbA integration toolkits disseminated to at least 20 LSGs across 4 districts (Output 4.1.1); and conduct at least 3 cross-district and cross-state peer learning workshops, with at least 20 LSGs integrating EbA into annual budgets and development plans, supported by digital adaptation platforms with confirmed post-project State Government ownership (Output 4.1.2).

- **Outcome 4.2:** Scaled and sustained climate adaptation and ecosystem restoration investments enabled through mobilization of blended, sustainable, and risk-informed finance, with explicit provisions for women-headed households and Indigenous Peoples.

Limited access to climate finance mechanisms constrains the scaling of adaptation investments beyond pilot areas. Component 4A will design and pilot at least 2 blended finance mechanisms leveraging NAFCC, GEF, GCF, state climate funds, CSR, and multilateral banks (Output 4.2.1). It will also operationalize existing local biodiversity funds providing small grants and loans to approximately 500 farmers, IPs, and women-led enterprises, as part of the

blended finance architecture; develop parametric risk transfer instruments and crop/livestock insurance mechanisms for at least 500 women-headed and Indigenous Peoples households across 4 target districts (Output 4.2.2).

The programme will be implemented across priority landscapes and communities within Wayanad, Kozhikode, Nilgiris, and Coimbatore. As part of the landscape approach, the project also recognises Malappuram district as a downstream benefit zone of the Chaliyar river basin, where upstream restoration and risk reduction investments in Wayanad and Kozhikode are expected to generate indirect hydrological and flood regulation benefits, and where project activities and models can be directly replicated given the shared ecological and socioeconomic context.

The programme directly contributes to the objectives of the Adaptation Fund, including:

- **AF Outcome 1:** Reduced exposure to climate-related hazards and threats, addressed through Output 1.1.1 (vulnerability mapping), Output 1.1.2 (slope stabilization), Output 1.1.3 (20 LEWS covering 10,000–15,000 households), and Output 1.1.4 (8,000 ha ecological restoration)
- **AF Outcome 2:** Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses, addressed through Output 1.1.3 (women and IP trained as EWS operators), Output 4.1.1 (State Training Centre; 13,200 BMC members trained), and Output 4.1.2 (20 LSGs with EbA embedded in budgets)
- **AF Outcome 3:** Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level, addressed through Output 4.1.1 (EbA toolkits disseminated to 20 LSGs), Output 4.1.2 (cross-state peer learning workshops; digital adaptation platforms)
- **AF Outcome 5:** Increased ecosystem resilience in response to climate change and variability-induced stress, addressed through Output 2.1.1 (at least 4 nurseries for native and non-invasive commercial species), Output 2.1.2 (4,000 ha invasive species clearance; soil restoration across 3,000 ha), and Output 3.1.1 (150 decentralized water systems)
- **AF Outcome 6:** Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas, addressed through Output 2.1.3 (land-based livelihoods training for approximately 2,000 women and IP households through composting enterprises, nursery operations, NTFP value chains, and agroforestry)
- **AF Outcome 7:** Improved policies and regulations that promote and enforce resilience measures, addressed through Output 4.1.1 (EbA integration into GPDs and DDMPs), Output 4.2.1 (blended finance mechanisms), Output 4.2.2 (parametric insurance).

The project also contributes to global and national biodiversity and sustainable development objectives, including:

- *GBF Target 1:* Integration of biodiversity values into policies, strategies, and planning
- *GBF Target 2:* Protection and restoration of nature and biodiversity
- *GBF Target 8:* Prevention and management of negative impacts of invasive alien species
- *GBF Target 22:* Capacity-building, knowledge sharing, and resource mobilization for biodiversity goals
- *SDG 1 – No Poverty:* Enhanced livelihoods and income security for vulnerable communities
- *SDG 2 – Zero Hunger:* Promotion of climate-resilient and sustainable agriculture
- *SDG 6 – Clean Water and Sanitation:* Improved water security through watershed restoration and decentralized water management
- *SDG 13 – Climate Action:* Strengthened local adaptation, disaster preparedness, and ecosystem-based risk reduction
- *SDG 15 – Life on Land:* Restoration and sustainable management of forests, grasslands, and degraded ecosystems

III. Project / Programme Components and Financing

Component	Expected Outcome	Expected Outputs	Budget (USD)
Component 1: Integrated climate risk assessment and ecosystem-based disaster risk reduction (Eco-DRR) (<i>Direct adaptation investment</i>)	Outcome 1.1: Reduced loss of life, livelihoods, and assets from landslides, extreme rainfall, and flash floods in the most acutely exposed settlements and catchments of the Nilgiri–Wayanad Corridor, through green-grey solutions	Output 1.1.1: 4 district-level composite vulnerability maps produced, integrating landslide and flood hazard data with social vulnerability indicators and sex-disaggregated data, embedded into at least 20 Gram Panchayat Development Plans and 4 District Disaster Management Plans across districts. Output 1.1.2: Approx. 500–700 vegetative bunds and contour trenches, 50 check dams, 50–70 gabion walls, and 200–300 recharge pits constructed to stabilize landslide-prone slopes in 2 montane districts (Nilgiris and Wayanad) and degraded catchments in acute hazard zones.	\$6,500,000

	and disaster preparedness.	Output 1.1.3: 20 community-level localized early warning systems (LEWS) deployed across high-landslide-risk settlements in 4 target districts, covering an estimated 10,000–15,000 households. Output 1.1.4: Approx. 8,000 ha of degraded forest, shola–grassland, and wildlife corridor habitats ecologically restored across 10–15 landscape sites in target districts, through native vegetation planting, shola–grassland restoration, and corridor and buffer zone management.	
Component 2: Climate-resilient livelihoods and invasive species management (<i>Direct adaptation investment</i>)	Outcome 2.1: Women and Indigenous Peoples households across 4 target districts derive sustainable climate-resilient livelihoods from ecosystem restoration investments	Output 2.1.1: At least 4 nurseries (including native and non-invasive commercial species) strengthened and operational, supplying planting stock for restoration activities and managed by IP and women as community enterprises integrating Indigenous knowledge. Output 2.1.2: Approx. 4,000 ha cleared of invasive species converted into organic compost via TNAU Biomineralizer (Tamil Nadu) and KAU microbial consortia (Kerala), channelled into organic farming and soil restoration across approx. 3,000 ha of horticultural landscapes in the 4 target districts. Output 2.1.3: Land-based livelihood training and equipment support for approx. 2,000 women and Indigenous Peoples households, through Lantana composting, nurseries, NTFP value chains, agroforestry, and restoration-linked enterprises across 4 target districts. <i>(An Indigenous Peoples Plan will be developed at full proposal stage with detailed benefit-sharing, land tenure considerations, and FPIC processes.)</i>	\$2,800,000
Component 3: Water Security and Hydrological Resilience (<i>Direct adaptation investment</i>)	Outcome 3.1: Reduced household water insecurity through green-grey interventions to address intensifying dry spells, groundwater depletion, and seasonal hydrological disruption.	Output 3.1.1: Approximately 150 decentralized water systems rehabilitated or constructed across 4 target districts, comprising approximately 40 priority springs rehabilitated, 50 check dams, 30 percolation pits, and 30 rainwater harvesting systems. <i>(Kerala: ~80 systems across Wayanad and Kozhikode; Tamil Nadu: ~70 systems across Nilgiris and Coimbatore. Exact numbers per district to be confirmed at full proposal stage.)</i>	\$ 1,850,000
Component 4: Empowered local self-governments in climate and biodiversity governance (<i>Enabling activities</i>)	Outcome 4.1: Local Self-Governments effectively plan, finance, and implement climate-resilient and biodiversity-positive actions through gender-responsive and Indigenous Peoples-inclusive governance systems across Kerala and Tamil Nadu. Outcome 4.2: Scaled and sustained climate	Output 4.1.1: 1 State Training Centre for EbA established in Kerala; 1,200 Biodiversity Management Committees (13,200 members) trained in climate-resilient EbA planning across Kerala and Tamil Nadu; and EbA integration toolkits disseminated to at least 20 LSGs across 4 districts Output 4.1.2: At least 3 cross-district and cross-state peer learning workshops conducted; at least 20 LSGs integrating EbA into annual budgets and development plans, supported by operational digital adaptation platforms. Output 4.2.1: At least 2 blended finance mechanisms designed and piloted, leveraging NAFCC, GEF, GCF, state climate funds, CSR, and multilateral banks, and building on existing local biodiversity funds delivering small grants to approx. 500 farmers, IP community members, and women-led enterprises across 4 districts. (Co-	\$1,000,000

	adaptation and ecosystem restoration investments enabled through mobilization of blended, sustainable, and risk-informed finance, with explicit provisions for women-headed households and Indigenous Peoples.	<i>financing leverage ratio to be confirmed at full proposal stage.)</i> Output 4.2.2: Parametric climate risk financing and crop/livestock insurance mechanisms designed and piloted for at least 500 women-headed and IP households.	
Component 5: M&E and Knowledge Management (Cross-cutting)			\$361,521
Participatory M&E framework with sex-disaggregated beneficiary data, quantitative targets (hectares restored, EWS established, springs rehabilitated, beneficiaries reached disaggregated by gender and Indigenous group), and adaptive management protocols.			
6. Project/Programme Execution cost (9.5%)			\$1,313,364
7. Total Project/Programme Cost			\$13,824,885
8. Project/Programme Cycle Management Fee charged by the Implementing Entity (8.5%)			\$1,175,115
Amount of Financing Requested			\$15,000,000

Projected Calendar:

Milestones	Expected Dates
Start of Project/Programme Implementation	December 2027
Mid-term Review	September 2030
Project/Programme Closing	December 2032
Terminal Evaluation	September 2033

PART II: PROJECT / PROGRAMME JUSTIFICATION

A. Project Components

Project Description:

The NWC faces a complex interplay of climate hazards, ecological degradation, and socio-economic vulnerability, requiring an integrated, landscape-scale response. Accelerated warming, erratic rainfall, landslides, flash floods, and prolonged dry spells are interacting with historical land-use changes, degraded forests, and socio-economic vulnerabilities to create compounded risks across the corridor. Smallholder farmers, indigenous groups, and marginalized communities, particularly women and the elderly, are disproportionately affected due to their dependence on climate-sensitive agriculture, forest resources, and water systems. Ecosystem degradation, including forest loss, habitat fragmentation, and invasive species proliferation, has weakened the natural buffers that traditionally mitigated these hazards, further intensifying exposure to climate extremes.

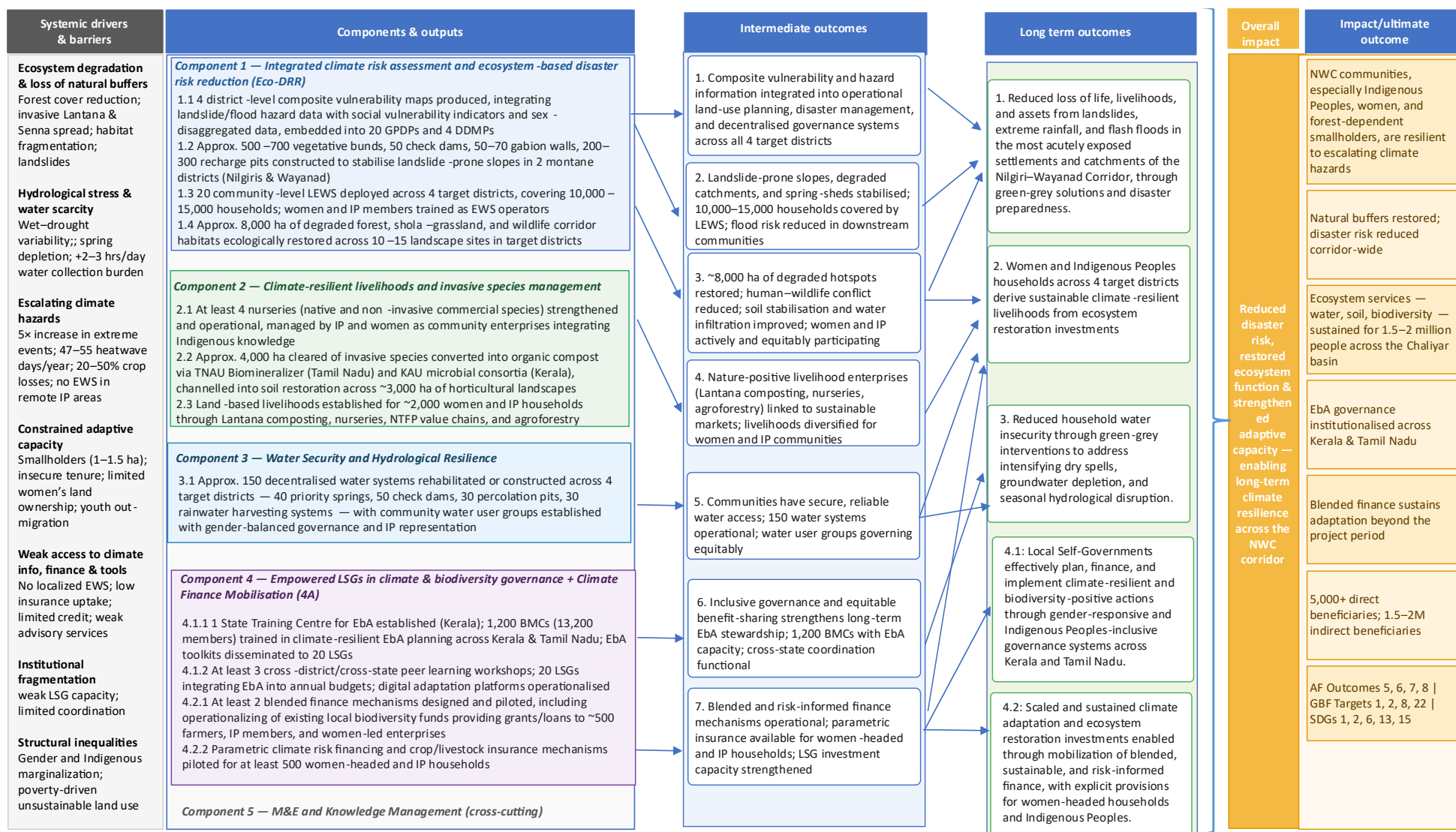
The project establishes a direct linkage between key climate risks and targeted adaptation responses. Escalating landslide and flood risks are addressed through composite vulnerability mapping, slope stabilization, and community-based localized early warning systems (LEWS) under Component 1. Water insecurity is addressed through dedicated spring-shed rehabilitation and decentralized water systems under the same component. Ecosystem degradation and human–wildlife conflict are addressed through targeted restoration of degraded hotspots, invasive species removal, and corridor management under Component 2. Institutional capacity constraints are addressed through strengthening Local Self-

Governments (LSGs) and enhancing cross-state coordination under Component 3. The project addresses underlying drivers such as agricultural encroachment, monoculture plantation expansion, and land tenure challenges affecting both smallholder and Indigenous communities. Restoration interventions are embedded within existing government programmes, including CAMPA, MGNREGS, and the National Mission for Green India, to ensure long-term sustainability. Invasive species, particularly *Lantana camara* and *Senna spectabilis*, are treated as core climate adaptation challenges, with removal linked to value-generating composting enterprises supported by TNAU.

Institutional Framework: The project will be implemented through a structured multi-level institutional framework. United Nations Environment Programme will serve as the Multilateral Implementing Entity, providing fiduciary oversight, technical quality assurance, and compliance with Adaptation Fund requirements. Ministry of Environment, Forest and Climate Change will act as the national coordinating authority, with its Wildlife Division supporting interventions related to human–wildlife conflict. At the state level, the Departments of Environment and Climate Change in Kerala and Tamil Nadu will serve as Executing Entities, ensuring coordination and convergence with relevant programmes such as CAMPA, MGNREGS, and state forestry initiatives. At the district level, District Disaster Management Authorities, Forest Departments, and line departments for Agriculture, Water Resources, and Rural Development will coordinate implementation across Wayanad, Kozhikode, Nilgiris, and Coimbatore. At the community level, Local Self-Governments, Gram Panchayats, Biodiversity Management Committees, women’s Self-Help Groups, Farmer Producer Organizations, and Indigenous governance institutions will serve as the primary implementing and governance bodies. To maximise impact and sustainability, the project will actively leverage and converge with ongoing national and state schemes related to agriculture (NMSA, PM-KISAN), natural resource management (CAMPA, GIM), rural livelihoods (MGNREGS, NRLM), watershed development (PMKSY, Integrated Watershed Management Programme), tribal development (TRIFED, Van Dhan Vikas Kendras, PVTG Mission), and ecosystem restoration (State Biodiversity Board programmes, Haritha Keralam Mission, Green Tamil Nadu Mission). Convergence modalities, including joint planning protocols, and shared monitoring frameworks, will be elaborated in detail during full proposal stage.

Indigenous Peoples - culturally appropriate participation and benefit-sharing: The project will apply Free, Prior, and Informed Consent (FPIC) principles throughout all stages of planning, implementation, and monitoring. Indigenous communities, including the Paniya, Kattunayaka, Adiya, Cholanaikka, Toda, Kota, Badaga, Kurumba, and Irula, will be engaged through culturally appropriate consultation processes facilitated by Indigenous governance institutions and trusted intermediaries. Indigenous knowledge systems will be integrated into vulnerability mapping, ecosystem restoration planning, and water resource management. Community members will be prioritized for employment in restoration activities, early warning system operations, and nursery management. Benefit-sharing mechanisms, including employment income, revenues from Lantana composting enterprises, and improved access to rehabilitated water sources, will be co-designed with communities and embedded within local governance systems. Indigenous women will receive targeted support to assume leadership roles in water user groups, early warning systems, and community monitoring platforms.

The TOC is given below.



Component 1: Integrated climate risk assessment and ecosystem-based disaster risk reduction (Eco-DRR)

The objective of this component is to strengthen climate-resilient land-use and disaster risk governance by generating a granular, landscape-specific evidence base and implementing Eco-DRR measures to reduce the impacts of landslides, extreme rainfall, and flash floods on vulnerable communities in the NWC. The project will produce landscape-scale composite vulnerability data and build the capacity of LSGs, district administrations, and communities to plan and implement nature-based solutions. This component intervenes directly in acute climate hazard zones, steep slopes, flood-prone catchments, and vulnerable settlements, using hazard mapping, bioengineering structures, landscape-scale ecological restoration, and early warning systems to reduce immediate and long-term disaster risk to lives and livelihoods. Exposure and institutional preparedness vary across districts and LSGs due to historical land-use change, forest degradation, and development pressures. The 2024 Wayanad landslides highlight the urgency of differentiated, location-specific disaster risk reduction. Climate change projections compound these pressures through more intense rainfall, more frequent extreme events, and accelerating groundwater depletion. Activities will adopt tailored strategies across LSGs, coordinated with District Disaster Management Authorities, line departments (Forestry, Agriculture, Rural Development, Public Works), Biodiversity Management Committees, and Indigenous governance institutions, with gender-responsive and Indigenous Peoples-inclusive planning and benefit-sharing embedded throughout.

Outcome 1.1: Reduced loss of life, livelihoods, and assets from landslides, extreme rainfall, and flash floods in the most acutely exposed settlements and catchments of the Nilgiri–Wayanad Corridor, through green-grey solutions and disaster preparedness.

Output 1.1.1: 4 district-level composite vulnerability maps produced, integrating landslide and flood hazard data with social vulnerability indicators and sex-disaggregated data, embedded into at least 20 Gram Panchayat Development Plans and 4 District Disaster Management Plans across districts.

Activities:

- Produce high-resolution, micro-zonation landslide and flood risk maps integrating climate projections, land-use change, hydrology, and slope stability analysis to identify priority risk areas and degraded catchments for intervention.
- Conduct participatory risk validation with communities, Indigenous Peoples, and local institutions, integrating Indigenous knowledge into composite vulnerability assessments.
- Embed composite vulnerability outputs into Gram Panchayat Development Plans (GPDPs), District Disaster Management Plans, and sectoral investment plans.
- Train local officials and stakeholders to use climate and hazard information for planning and emergency response, including the development of a GIS-based spatial planning and monitoring framework for the project. The system will geo-reference all intervention sites and restoration activities, enabling monitoring of ecological restoration, slope stabilization, water rehabilitation, and livelihood development over the project period.

Output 1.1.2 Approx. 500–700 vegetative bunds and contour trenches, 50 check dams, 50–70 gabion walls, and 200–300 recharge pits constructed to stabilize landslide-prone slopes in 2 montane districts (Nilgiris and Wayanad) and degraded catchments in acute hazard zones.

Activities:

- Conduct targeted, site-specific watershed and slope stability assessments in priority areas identified under Output 1.1.1, to guide detailed design of ecosystem-based bioengineering and watershed management measures.
- Implement ecosystem-based bioengineering measures, including vetiver grass planting, bamboo fencing, native shrubs, and vegetative hedgerows, to stabilize vulnerable slopes and reduce soil erosion. Indicative targets: 500–700 vegetative bunds and contour trenches across priority sites.
- Construct integrated structural and vegetative measures, including contour trenches, bunds, check dams (indicative: 50), recharge pits (indicative: 200–300), gabion walls (indicative: 50–70), and biofiltration structures at critical drainage points, to manage surface runoff, enhance groundwater recharge, and reduce sedimentation. In line with Tamil Nadu Water Resources Department guidance, conventional desilting methods will not be used; context-specific sediment management strategies- catchment soil conservation, slope stabilization, vegetative buffers, and nature-based solutions, will be integrated with watershed management and climate projections.
- Deployment of nature-based solutions (vetiver grass, hedgerows, contour trenches, and check dams) in midstream valleys and riparian zones of the Chaliyar and Bhavani tributaries to enhance recharge, stabilise slopes, and reduce sedimentation in Kozhikode and Coimbatore.
- Engage local communities including women's groups in planning, construction, planting, and maintenance to strengthen local stewardship and generate livelihood co-benefits.

Output 1.1.3 20 community-level localized early warning systems (LEWS) deployed across high-landslide-risk settlements in 4 target districts, covering an estimated 10,000–15,000 households.

Under this, the systems will address escalating landslide, flood, and extreme rainfall risks driven by degraded slopes, forest loss, agricultural encroachment, and unregulated infrastructure, using low-cost IoT rain and soil moisture sensors linked to SMS/radio alerts in local languages. They will be aligned with IMD rainfall thresholds and NLFC protocols, integrated into District Disaster Management Plans and SDMA/NDMA response chains, and supported by women and Indigenous Peoples trained as operators, with O&M embedded in LSGs and PRIs for sustainability. The intervention will also be integrated with decentralized water resilience measures tailored to local conditions, including rooftop well-recharge systems (Mazhapolima model), ferro-cement community storage tanks (VARSHA/KWA model), and rehabilitation of traditional Panam Keni wells in Indigenous Peoples settlements in Wayanad and the Nilgiris.

Activities:

- Deploy LEWS using IoT sensors aligned with IMD rainfall thresholds and NLFC protocols to provide real-time monitoring of slope stability and precipitation across landslide, flood, and extreme rainfall hazard zones.
- Train local emergency response teams and community volunteers, prioritising women and Indigenous community members, to manage EWS equipment and execute alert protocols.
- Conduct community awareness campaigns, drills, and capacity-building workshops reaching at least 10,000 households to ensure preparedness and effective response.
- Integrate EWS data and protocols into District Disaster Management Plans and GPDPs for institutional continuity.

Output 1.1.4: Approx. 8,000 ha of degraded forest, shola–grassland, and wildlife corridor habitats ecologically restored across 10–15 landscape sites in target districts, through native vegetation planting, shola–grassland restoration, and corridor and buffer zone management.

Under this active participation of women and Indigenous Peoples integrated into planning, implementation, and benefit-sharing. Wildlife Division of MoEFCC to be consulted on human–wildlife conflict interventions during full proposal formulation. Restoration activities under Output 1.1.4 will be designed to converge with the National Mission for Green India (GIM), channelled through the State Forest Departments of Kerala and Tamil Nadu, to ensure long-term site maintenance beyond the project period.

Activities:

- Assess and map priority degraded hotspots using climate-risk-informed land-use planning considering habitat degradation, wildlife movement corridors, and settlement patterns, while aligning restoration planning with the Working Plans and Working Scheme prescriptions of the State Forest Departments of Kerala and Tamil Nadu. Joint Forest Management Committees (JFMCs) and Eco-Development Committees (EDCs) in the corridor will be engaged as community co-implementation bodies to strengthen local ownership and build on existing participatory forest governance structures.
- Restore soil stability, forage availability, and habitat quality within forest areas and corridors to reduce climate-induced wildlife movement into human settlements and enhance water infiltration. Address root causes of habitat fragmentation, monoculture expansion and unregulated infrastructure, through corridor restoration, wildlife-friendly land-use planning, and buffer zone management, embedded within CAMPA, MGNREGS, and state forestry schemes to address structural drivers beyond project scope.
- Implement targeted ecosystem interventions, native vegetation planting, contour trenches, and vegetative barriers, to stabilize slopes, improve hydrology, and install non-invasive, climate-resilient deterrents (solar fencing, bee fences, chili barriers) in high-conflict zones to protect crops and livelihoods, prioritizing restoration will Assisted Natural Regeneration (ANR) with active native species planting only where natural regeneration is insufficient.
- Establish and strengthen community-based wildlife monitoring and mitigation committees with participation of women, youth, and Indigenous Peoples.
- Improve access to conflict risk information and early alerts through coordination with Forest Departments and local authorities.

Component 2: Climate-resilient livelihoods and invasive species management

The objective of this component is to transform landscape restoration into lasting economic opportunity for communities, women, and Indigenous Peoples through invasive species composting enterprises, native nursery operations, and climate-resilient livelihood systems. Building on the ecological restoration investments under Component 1, this component focuses on the livelihood and land management systems that sustain restoration outcomes, systematically removing invasive species that reduce soil infiltration capacity, increase surface runoff, and accelerate the depletion of springs and

groundwater sources, and converting them into productive enterprises that generate direct income for women and Indigenous community members.

Activities focus on approximately 8,000 ha across 10–15 priority sites and will be implemented in close coordination with LSGs, Forest and Revenue Departments, Biodiversity Management Committees, and community institutions. Invasive species spread under intensifying drought and heat stress is treated as a core climate adaptation challenge, *Lantana camara* and *Senna spectabilis* directly suppress natural regeneration, elevate fire risk, reduce slope stability, and accelerate groundwater depletion, contributing to the same hazard pathways addressed in Component 1. Their removal and productive conversion is therefore a central climate adaptation measure, linking invasive species management explicitly to hydrological resilience and slope protection goals. Human–wildlife conflict driven by habitat fragmentation and climate stress is addressed as a landscape-scale risk to be managed through ecological restoration and corridor connectivity. The Wildlife Division of MoEFCC will be consulted on human–wildlife conflict interventions during full proposal formulation.

Outcome 2.1: Women and Indigenous Peoples households across 4 target districts derive sustainable climate-resilient livelihoods from ecosystem restoration investments.

Output 2.1.1. At least 4 nurseries (including native and non-invasive commercial species) strengthened and operational, supplying native planting stock for restoration activities and managed by IP and women as community enterprises integrating Indigenous knowledge.

Activities:

- Assess and strengthen existing native and non-invasive commercial species nurseries in target LSGs and train nursery staff and community groups with a strong focus on women's participation and leadership.
- Train nursery staff, women's self-help groups, and Indigenous community members in native and non-invasive commercial species propagation, nursery management, and quality control, with Indigenous knowledge of local plant species and ecological functions integrated into training content and nursery practice.
- Establish community enterprise governance structures for each nursery, ensuring women and Indigenous Peoples hold operational and decision-making roles, with benefit-sharing arrangements agreed through participatory processes.
- Develop supply chain linkages between nurseries and restoration planting programmes, ensuring reliable native planting stock supply to all 10–15 restoration sites across 4 districts.

Output 2.1.2: Approx. 4,000 ha cleared of invasive species converted into organic compost via TNAU Biomineralizer (Tamil Nadu) and KAU microbial consortia (Kerala), channeled into organic farming and soil restoration across approx. 3,000 ha of horticultural landscapes in the 4 target districts.

Activities:

- Conduct invasive species mapping and prioritization in restoration sites, focusing on *Senna spectabilis* and *Lantana camara* as core climate adaptation targets, not biodiversity co-benefits, given their direct role in amplifying landslide risk, forest fire frequency, and water infiltration loss.
- Implement systematic invasive species removal campaigns across approximately 4,000 ha of restoration sites, combined with assisted natural regeneration of native species to support long-term ecological recovery.
- Develop and implement site-specific restoration strategies for 10–15 priority sites, including phased removal of *Lantana camara* and *Senna spectabilis*, immediate post-removal measures (soil scarification, native seed broadcasting, and ANR to prevent re-invasion), defined monitoring and re-treatment thresholds, and multi-year maintenance arrangements through community stewardship agreements with JFMCs and Biodiversity institutions.
- Integrate TNAU Biomineralizer technology (Tamil Nadu) and KAU microbial consortia (Kerala) to convert harvested *Lantana* biomass into productive organic compost, channelled into soil restoration across approximately 3,000 ha of horticultural landscapes, directly linking invasive species management to soil health and agricultural productivity goals.
- Promote organic farming, composting, and mulching practices across horticultural landscapes to address soil organic matter loss and reduced water-holding capacity from excessive chemical fertiliser use, in line with Tamil Nadu Horticulture Department recommendations.
- Application of *Lantana* biomass compost, produced through TNAU Biomineralizer technology, for organic mulching and soil restoration in horticultural landscapes across the Nilgiris, aimed at reducing topsoil erosion and surface runoff while enhancing the natural forest sponge function in this high-erosion zone.
- Monitor restoration sites for native vegetation recovery and manage risks of invasive species re-establishment through follow-up control measures.

Output 2.1.3: Land-based livelihood training and equipment support for approx. 2,000 women and Indigenous Peoples households, through Lantana composting, nurseries, NTFP value chains, agroforestry, and restoration-linked enterprises across 4 target districts. (An Indigenous Peoples Plan will be developed at full proposal stage with detailed benefit-sharing, land tenure considerations, and FPIC processes.)

Activities:

- Establish approximately 20 Lantana composting enterprises (5 per district) for women and Indigenous Peoples households, including Paniya, Kattunayaka, and Cholanaikka communities, providing direct income without requiring land ownership, directly linked to invasive species removal under Output 2.1.2.
- Develop NTFP value chains linking Indigenous knowledge of medicinal plants, wild honey, bamboo, and forest produce to local markets, with aggregation and packaging support for approximately 500 women and Indigenous Peoples households across 4 target districts.
- Establish agroforestry systems on community and common lands for approximately 2,000 households, integrating native species, shade-grown crops, and fodder plants, with seedlings sourced from nurseries under Output 2.1.1 and technical support from agriculture and forest departments.
- Provide enterprise development support, financial literacy training, and facilitate access to grants and loans through local biodiversity funds without land collateral requirements, with participatory benefit-sharing mechanisms developed ahead of the full Indigenous Peoples Plan at full proposal stage.

Component 3: Water Security and Hydrological Resilience (Direct adaptation investment)

The objective of this component is to address climate-driven hydrological stress as a distinct and critical adaptation challenge in the NWC, following the logic of the project's climate impact chain in which hydro-climatic shifts, reduced baseflows, groundwater decline, and seasonal water scarcity, represent a separate impact pathway from slope instability and ecosystem degradation. Intensifying dry spells, erratic monsoon patterns, and the depletion of springs and shallow aquifers are threatening domestic and agricultural water security for communities across Wayanad, Kozhikode, Nilgiris, and Coimbatore, with women and Indigenous Peoples facing disproportionate burdens. High resolution hydrogeological mapping of drying traditional springs across the upper montane forested catchments of Wayanad and the Nilgiris plateau is a foundational investment under this component, ensuring that catchment treatment and recharge zone protection are precisely targeted to preserve the headwaters of the vital Bhavani, Chaliyar, and Kabani river systems. A projected freshwater deficit of 214 MCM by 2040 in the Chaliyar basin underscores the urgency of dedicated hydrological investment. This component rehabilitates degraded springs, catchments, and decentralised water infrastructure, and establishes community water user groups with gender-balanced governance and Indigenous Peoples representation to ensure equitable access and post-project sustainability. Activities will be implemented in coordination with Kerala Water Authority, Tamil Nadu Water Resources Department, LSGs, and Biodiversity Management Committees, with explicit integration into LSG planning and budgeting.

Outcome 3.1: Reduced household water insecurity through green-grey interventions to address intensifying dry spells, groundwater depletion and seasonal hydrological disruption.

Output 3.1.1: Approximately 150 decentralized water systems rehabilitated or constructed across 4 target districts, comprising approximately 40 priority springs rehabilitated, 50 check dams, 30 percolation pits, and 30 rainwater harvesting systems. *(Kerala: ~80 systems across Wayanad and Kozhikode; Tamil Nadu: ~70 systems across Nilgiris and Coimbatore. Exact numbers per district to be confirmed at full proposal stage.)*

Activities:

- Rehabilitate springs, spring-sheds, and traditional water sources through high-resolution hydrogeological mapping of drying traditional springs across the upper montane forested catchments of Wayanad and the Nilgiris plateau, followed by spring-shed mapping, catchment treatment, recharge zone protection, and flow regulation measures, with priority given to springs that serve Indigenous Peoples' settlements and women-headed households most vulnerable to seasonal water scarcity.
- Promote household and community-level rainwater harvesting systems including rooftop well-recharge systems using the Mazhapolima model (Kerala hill districts) and ferro-cement community storage tanks using the VARSHA/KWA model (Tamil Nadu), tailored to local hydrogeological conditions across Wayanad and Kozhikode (Kerala) and Nilgiris and Coimbatore (Tamil Nadu).

- Deployment of decentralised rainwater harvesting systems, including storage structures, percolation pits, and soil-moisture monitoring tools, across rainfed smallholder farming areas in the corridor, to enhance local water availability by capturing and utilising high-velocity monsoon runoff and improving soil moisture retention in degraded slopes.
- Introduce participatory water monitoring systems including simple tools for tracking groundwater levels, spring discharge, and seasonal availability, with women and Indigenous community members trained as community water monitors.
- Establish community water user groups with gender-balanced governance structures and Indigenous Peoples representation and build their capacity to operate and maintain water systems and integrate spring-shed water management into LSG planning and budgeting for post-project sustainability.

Component 4: Empowered local self-governments in climate and biodiversity governance (Enabling activities)

The objective of this component is to mainstream climate resilience and EbA into government planning, budgeting, and implementation systems, thereby institutionalizing locally led adaptation. The project will embed climate risk management into the statutory functions of LSGs, ensuring adaptation becomes a permanent feature of decentralized governance. Activities target PRI representatives, women's SHGs, Biodiversity Management Committees, Farmer Producer Organizations, Indigenous councils, and frontline officials. The project will facilitate scheme convergence, develop standardized adaptation sub-project templates, and institutionalize local stewardship through cross-departmental coordination.

Outcome 4.1: Local self-governments effectively plan, finance, and implement climate-resilient and biodiversity-positive actions through gender-responsive and Indigenous Peoples-inclusive governance systems across Kerala and Tamil Nadu.

Output 4.1.1: 1 State Training Centre for EbA established in Kerala; 1,200 Biodiversity Management Committees (13,200 members) trained in climate-resilient EbA planning across Kerala and Tamil Nadu; and EbA integration toolkits disseminated to at least 20 LSGs across 4 districts

Activities:

- Establish the State Training Centre for EbA as the coordinating anchor for knowledge hubs, with the Kerala State Biodiversity Board leading training of 13,200 members across 1,200 Biodiversity Management Committees to embed EbA in local governance.
- Conduct structured capacity-building workshops for LSG officials, PRI representatives, BMCs, women SHGs, and Indigenous councils on climate-resilient and ecosystem-based planning approaches.
- Develop and disseminate technical guidelines and toolkits for integrating EbA and biodiversity actions into GPDPs, sectoral plans, and annual budgets.
- Facilitate inclusive community consultations to ensure meaningful participation of Indigenous groups, women, and marginalized stakeholders in local adaptation planning.
- Embed climate risk and EbA into local planning, budgeting, and implementation across water, agriculture, forestry, and disaster management sectors.

Output 4.1.2 At least 3 cross-district and cross-state peer learning workshops conducted; at least 20 LSGs integrating EbA into annual budgets and development plans, supported by operational digital adaptation platforms.

Activities:

- Conduct peer-learning workshops and cross-district/state exchanges to share EbA practices, innovations, and lessons learned.
- Provide technical assistance and on-the-ground mentoring to community groups and LSGs on planning, implementing, and monitoring local adaptation actions.
- Establish platforms for cross-boundary and basin-level coordination and learning, with digital platforms institutionally owned by State Government departments post-project.

Component 4A: Climate Finance Mobilization

Outcome 4.2: Scaled and sustained climate adaptation and ecosystem restoration investments enabled through mobilization of blended, sustainable, and risk-informed finance, with explicit provisions for women-headed households and Indigenous Peoples.

Output 4.2.1: At least 2 blended finance mechanisms designed, documented, and piloted, leveraging NAFCC, GEF, GCF, state climate funds, CSR, and multilateral banks.

Under this, the project will also leverage existing local biodiversity funds, which is already operational and delivering small grants and loans to farmers, Indigenous community members, and women-led enterprises, as part of the blended finance architecture (*Co-financing leverage ratio to be confirmed at full proposal stage.*)

Activities:

- Identify, prioritize, and package scalable ecosystem restoration, water security, and climate adaptation investments into a pipeline of finance-ready projects.
- Design and pilot blended finance structures combining public funds, climate finance, CSR, and private capital to de-risk investments and improve bankability. Note: at concept note stage, the project will identify, design, and pilot mechanisms; full operationalization and institutionalization will follow at full proposal stage.
- Strengthen LSG capacity to access and deploy adaptation finance through standardized investment templates, financial appraisal tools, and fiduciary support.
- In horticultural landscapes in the Nilgiris, expand terrace farming to reduce runoff and topsoil loss, implement large-scale vetiver planting for slope stabilization, and promote organic farming, composting, and mulching to restore soil health, in line with Tamil Nadu Horticulture Department recommendations.
- Establish partnerships with NAFCC, GEF, GCF, state climate funds, CSR sources, and multilateral banks to mobilize capital and ensure long-term financing pathways.

Output 4.2.2: Parametric climate risk financing and crop/livestock insurance mechanisms designed and piloted for at least 500 women-headed and IP households.

Activities:

- Assess existing disaster risk financing instruments and gaps at Panchayat and district levels including contingency funds, relief mechanisms, and social protection linkages.
- Facilitate access to crop, livestock, and asset insurance schemes by simplifying enrollment, documentation, and claims processes for vulnerable households, especially women-headed and Indigenous households.
- Pilot parametric risk transfer instruments linked to rainfall intensity, landslide thresholds, or extreme weather triggers, aligned with district disaster management systems.
- Train LSG officials, SHGs, FPOs, and community institutions in financial preparedness, post-disaster fund mobilisation, and rapid disbursement protocols.

B. New and innovative solutions to climate change adaptation

The project promotes innovation by shifting from reactive, fragmented interventions to a proactive, landscape-scale adaptation model that integrates ecosystem restoration, technology, and decentralized governance across the NWC. Innovation is embedded in its approaches, technological deployments, and financial mechanisms, ensuring locally led, scalable, and sustainable adaptation.

- **Innovative approaches:** The project operationalizes landscape-scale planning by linking upstream forested “source” areas to downstream agricultural and urban “sink” zones, addressing hydrological and ecological interconnections. It establishes transboundary coordination between Kerala and Tamil Nadu, harmonizing forest, water, and disaster-risk governance across state lines. Locally led adaptation is institutionalized by embedding climate risk management and EbA into Gram Panchayat Development Plans and Local Self-Government functions, ensuring adaptation becomes a permanent governance feature. The project also implements community-based disaster and wildlife management, engaging village committees, women, youth, and marginalized groups in monitoring, early warning, and mitigation actions. Nature-based solutions, including slope stabilization, invasive species control, and native species planting, reduce disaster risk, enhance water regulation, and restore biodiversity.
- **Innovative technologies:** The project leverages IoT-based LEWS to monitor slope stability and rainfall, enabling anticipatory action against landslides and flash floods. AI-enabled wildlife monitoring provides early alerts on animal movement, reducing human–wildlife conflict. Digital adaptation dashboards consolidate climate, hydrological, and restoration data to inform evidence-based decision-making at LSG and corridor levels; these dashboards will be hosted and maintained post-project by the State Government departments of Environment and Climate Change in Kerala and Tamil Nadu respectively, with institutional ownership formally transferred during the final 12–18 months of the project through a structured handover process embedded in the exit strategy. Nature-based bioengineering techniques, including vetiver grass, bamboo fencing, vegetative hedgerows, contour trenches, check dams, and biofiltration structures, offer cost-effective and ecologically sensitive alternatives to conventional grey infrastructure.

- **Innovative financial and governance mechanisms:** The project introduces blended and risk-informed financing, combining public funds, climate finance, CSR, and private capital to scale ecosystem restoration, water security, and climate-resilient livelihood investments. Parametric risk transfer instruments linked to rainfall intensity or landslide thresholds enable rapid payouts, enhancing community shock response. Standardized planning templates and scheme convergence facilitate efficient, coordinated action by LSGs. Large-scale capacity building and participatory monitoring engage diverse stakeholders, strengthening accountability, adaptive management, and the institutionalization of climate-resilient governance.
- **Outcome-oriented approaches:** Through these approaches, technologies, and financial mechanisms, the project delivers integrated, proactive climate adaptation instead of fragmented, reactive interventions. It supports scalable, locally led solutions for disaster risk reduction, water security, and human–wildlife coexistence while restoring ecosystem connectivity. Inclusive participation of women, Indigenous Peoples, and marginalized groups ensures equity in adaptation planning and implementation. Finally, the design enables replication and scaling beyond the NCC pilot landscapes, creating a model for coordinated, landscape-level climate resilience interventions.

C. Economic, Social, and Environmental Benefits

The NWC project is designed to generate broad economic, social, and environmental benefits, with particular focus on the most vulnerable communities, including Indigenous groups, women, and smallholder farmers, while adhering to the Adaptation Fund's Environmental and Social Policy (ESP). By combining landscape-scale ecosystem restoration, nature-based solutions, dedicated water security investments, climate-resilient livelihoods, decentralized governance, and risk-informed planning, the project simultaneously reduces disaster risks, strengthens adaptive capacity, and promotes sustainable development.

Economic benefits: This project aims to transform livelihoods from precarious, climate-sensitive activities into stable, nature-based sources of income. Restoration of over 8,000 hectares of degraded landscapes, including shola forests, montane grasslands, and landslide-prone slopes, across an estimated 10–15 priority pilot sites will create direct employment opportunities in planting, bioengineering, and nursery management, with roles are expected to reach around at least 5,000 households, with women and marginalized groups actively involved, promoting both economic inclusion and local stewardship. The project also strengthens community-based micro-enterprises, such as Lantana biomass composting in partnership with TNAU using microbial composting technology, beekeeping, and structured collection of Minor Forest Produce (MFP). These enterprises generate marketable, value-added products, support local incomes, and revive biodiversity-linked livelihoods. Lantana camara and Senna spectabilis removal is treated as a core climate adaptation measure, not a biodiversity co-benefit, given its direct role in reducing landslide risk, forest fire frequency, and water infiltration loss. Agroforestry and climate-resilient agricultural practices, including shade-grown coffee, millets, and drought-tolerant crops, stabilize yields, reduce losses, and enhance resilience to erratic rainfall and prolonged dry spells.

Financial resilience is addressed through parametric insurance and anticipatory finance mechanisms that provide rapid payouts after extreme rainfall, landslides, or floods. Finance sources include NAFCC, GEF, GCF, state climate funds, CSR, and multilateral banks. Watershed restoration and dedicated decentralized water infrastructure, including spring-shed rehabilitation, check dams, percolation pits, and rainwater harvesting systems governed by community water user groups with gender-balanced governance structures, support livelihoods by ensuring reliable water availability for irrigation and livestock, further reducing climate-related income losses.

Social benefits: Social inclusion is central to the NWC project, with a focus on indigenous groups, women, and other marginalized groups. Approximately 20 Localized Early Warning Systems (LEWS), addressing landslides, floods, and extreme rainfall, aligned with IMD rainfall thresholds and National Landslide Forecasting Centre (NLFC) protocols, participatory landslide micro-zonation using composite vulnerability maps integrating physical hazard data with social vulnerability indicators (poverty, gender, Indigenous status), and community hazard mapping directly safeguard lives and property in high-risk settlements, targeting an estimated 10,000–15,000 households across the 4 target districts. Water and nutrition security are enhanced through spring-shed rejuvenation, catchment protection, and the establishment of community seed banks for millets. These measures improve year-round access to potable water and nutritious food, particularly for first-generation learners, smallholder households, and Indigenous groups

The project strengthens local governance by integrating climate adaptation into Gram Panchayat Development Plans (GPDs) and establishing adaptation cells. It builds capacity across local institutions, officials, and community groups through structured training systems, including biodiversity management committees and a dedicated State Training Centre for Ecosystem-based Adaptation, ensuring inclusive participation in adaptation planning and implementation. Human–wildlife conflict is addressed through non-invasive, community-led strategies, including habitat restoration, fodder planting, and soft deterrents like bee fences and chili barriers. These measures reduce crop and livestock losses, protect lives, and

improve social stability in high-conflict areas. Integrated water and forest management interventions also contribute to human health by reducing waterborne disease risk and minimizing pesticide exposure.

Environmental benefits: The project leverages Nature-based Solutions (NbS) to restore critical ecosystem services and strengthen climate resilience. Removal of invasive species (*Lantana camara*, *Senna spectabilis*) and replanting with native vegetation enhances biodiversity, stabilizes slopes, and restores the “natural sponge effect” crucial for hydrological regulation in the corridor. Catchment and watershed restoration measures, including indicative 200–300 recharge pits, 50 check dams, and 500–700 contour bunds, improve soil moisture retention, regulate surface runoff, and enhance groundwater recharge, addressing “wet-drought” conditions caused by erratic monsoon patterns. These interventions also reduce sedimentation, mitigate flood risk, and enhance water security for downstream communities in Malappuram and Kozhikode districts. The substitution of grey infrastructure with nature-based solutions, vetiver grass, hedgerows, contour trenches, and check dams along the Chaliyar and Bhavani tributaries, further enhances recharge, stabilises slopes, and reduces sedimentation in Kozhikode and Coimbatore.

The project strengthens habitat connectivity by securing wildlife corridors and buffer zones for species such as the Nilgiri tahr, tiger, and Asian elephant, which reduces human–wildlife conflict and maintains ecological integrity. Where project activities alone cannot counter monoculture conversion, a structural driver rooted in land tenure policy and agricultural markets, restoration investments are embedded within CAMPA, MGNREGS, state forestry schemes, and the National Mission for Green India to ensure long-term sustainability. Carbon sequestration is enhanced through reforestation, grassland restoration, and agroforestry, contributing to India’s Nationally Determined Contributions (NDCs) as a secondary co-benefit of adaptation activities, with climate adaptation remaining the primary and central purpose of all project components. Overall, ecosystem restoration improves biodiversity, soil fertility, water quality, and hydrological regulation, generating long-term environmental and socio-economic benefits.

D. Cost effectiveness of the Project

This project is presented as a regional initiative with activities organised across five strategic components aimed at maximising climate adaptation and biodiversity outcomes in the NWC. The interventions focus on enhancing the resilience of vulnerable populations, including women, Indigenous Peoples, and forest-dependent smallholders, who are highly exposed to landslides, floods, water scarcity, and human–wildlife conflict. It is estimated that these activities will directly benefit over 10,000–15,000 households, including approximately 2,000 women and Indigenous Peoples households through land-based livelihood enterprises, and an estimated 1,500–2,250 households through rehabilitated decentralised water systems, and indirectly safeguard the livelihoods and ecosystems supporting 1.5–2 million people across the Chaliyar River Basin. The regional approach allows for cost rationalisation by avoiding duplication of efforts across states, pooling technical expertise, and facilitating knowledge exchange among stakeholders. By combining ecosystem-based disaster risk reduction, invasive species management, dedicated water security investments, livelihood diversification, and strengthened local governance, the project presents a highly cost-effective pathway for long-term, scalable climate adaptation. Climate adaptation is the primary and central purpose of all components; carbon sequestration and biodiversity co-benefits are secondary outcomes of adaptation activities. The adaptation finance gap for developing countries is estimated at USD 215–387 billion per year, underscoring the urgency of maximising cost-effectiveness within available resources (UNEP, 2023). Evidence demonstrating the cost-effectiveness and sustainability of the proposed measures is presented below.

Component 1: Integrated Climate Risk Assessment and Ecosystem-based Disaster Risk Reduction (Eco-DRR) (Budget: USD 6,500,000- approx. 43% of grant)

Effective land and watershed management is central to reducing vulnerability to climate hazards in the high-volatility landscapes of the NWC. Component 1 focuses on generating a landscape-specific evidence base and implementing Eco-DRR measures to reduce landslide and extreme rainfall risks. At an allocated budget of USD 6,500,000 across 4 districts, the component delivers an indicative per-household coverage cost of approximately USD 430–650 across the 10,000–15,000 households targeted by the early warning systems, a highly favourable unit cost for a multi-hazard package that simultaneously includes vulnerability mapping, slope stabilization, landscape-scale ecological restoration, and early warning system deployment across 4 districts.

Output 1.1.1: (4 district-level composite vulnerability maps at USD 200,000) delivers landscape-scale climate risk data at a cost of USD 50,000 per district, embedded into at least 20 Gram Panchayat Development Plans and 4 District Disaster Management Plans, generating durable public planning assets at a negligible per-beneficiary cost of approximately USD 3–5 per GPDP-covered household. Comparable district-level hazard mapping exercises in India have been costed at USD 80,000–150,000 per district under government programmes, confirming the project’s cost efficiency for this output.

Output 1.1.2: (slope stabilization structures in 2 montane districts at USD 2,000,000) delivers approximately 500–700 vegetative bunds, 50 check dams, 50–70 gabion walls, and 200–300 recharge pits at approximately USD 1,000,000 per

district. Stabilization of slopes and degraded catchments through ecosystem-based bioengineering, including vetiver grass planting, bamboo fencing, and vegetative hedgerows, provides low-cost, self-sustaining alternatives to conventional engineering approaches. Peer-reviewed literature confirms that vetiver grass-based bioengineering offers slope stabilization at a fraction of the cost of conventional concrete and masonry structures, while outperforming them on hydrological failure mechanisms including pore-pressure management and surface runoff, the primary drivers of landslide risk in the NWC (Vetiver Network International, 2025). Studies confirm vetiver reduces soil erosion by 85–92% on comparable tropical slopes (Natural Hazards Review, ASCE 2024). For reference, government construction cost estimates for a conventional masonry retaining wall in Indian hill terrain run approximately ₹12,879 per running metre for a 3m-high wall (Gol PWD Schedule of Rates), and gabion retaining walls used for landslide protection on NH-47 passing through Kerala and Tamil Nadu illustrate the engineering baseline for grey infrastructure slope protection in comparable NWC terrain. At an indicative cost of USD 2,500–3,500 per vegetative bund and USD 15,000–25,000 per check dam, the project's ecosystem-based approach delivers comparable or superior slope protection outcomes at 40–60% of the cost of equivalent grey infrastructure alternatives. Extending this NbS approach along the midstream valleys and riparian zones of the Chaliyar and Bhavani tributaries further multiplies cost-effectiveness by simultaneously maximising aquifer recharge, stabilising slopes, and mitigating downstream sedimentation in Kozhikode and Coimbatore, without the lifecycle costs of conventional grey infrastructure. The 2024 Wayanad landslide resulted in over 400 deaths and losses of approximately ₹1,200 crore, providing a direct, locally verified proxy for the economic cost of inaction and the return on pre-emptive investment in slope stabilisation and early warning.

Output 1.1.3: (20 LEWS at USD 200,000) deploys approximately 20 community-level early warning systems at an estimated cost of USD 3,000–5,000 per system, each covering 500–750 households. The Global Commission on Adaptation finds a cost-benefit ratio of 1:9 for multi-hazard early warning systems, meaning every USD 1 invested in EWS generates an average of USD 9 in net economic benefits, making LEWS among the highest-returning adaptation measures available (WMO, 2023). The WMO further notes that an early warning of just 24 hours can reduce potential disaster damages by 30%, and that EWS provides a nearly tenfold return on investment. At USD 3,000–5,000 per LEWS system serving an estimated 500–750 households, the indicative cost per household covered is USD 4–10, compared to a national average of USD 25–40 per household for centralised government-operated EWS infrastructure, confirming the cost efficiency of the project's community-level last-mile approach.

Output 1.1.4: (8,000 ha ecological restoration at USD 4,100,000) delivers landscape-scale restoration at approximately USD 512 per hectare. Research on restoration projects conducted over 20 years in the Anamalai Hills of the Western Ghats, ecologically comparable to the NWC target area, confirms the viability of mixed native species planting and invasive weed removal as cost-effective active restoration methods in this landscape, with documented restoration costs in the range of USD 400–800 per hectare (Osuri et al., 2019). The project's indicative cost of USD 512 per hectare sits within this evidence-based range and is further reduced through MGNREGS and CAMPA convergence financing embedded within existing government programmes. For comparison, conventional grey infrastructure alternatives for equivalent slope protection and water retention functions, such as retaining walls, engineered drainage channels, and concrete check weirs, would cost an estimated USD 5,000–15,000 per hectare of equivalent coverage, making the nature-based restoration approach 10–30 times more cost-effective on a per-hectare basis.

Participatory approaches and institutional capacity-building strengthen long-term sustainability. Training local officials, women's groups, and Indigenous communities with FPIC principles applied throughout, to utilise climate and hazard data ensures ownership of interventions and reduces the risk of maladaptation. Evidence from regional initiatives demonstrates that combining early warning systems with nature-based slope stabilisation and community engagement significantly reduces future economic losses while providing ecosystem co-benefits, making Component 1 highly cost-effective.

Component 2: Climate-resilient Livelihoods and Invasive Species Management (Budget: USD 2,800,000, approx. 19% of grant)

Component 2 implements targeted invasive species management and livelihood enterprise development that simultaneously restores ecological function, improves hydrological performance, and generates direct income for women and Indigenous Peoples households across 4 target districts. At a combined budget of USD 2,800,000 for three outputs, the component delivers an indicative cost of USD 700 per direct livelihood beneficiary household, a cost-effective rate for a multi-benefit investment that simultaneously addresses invasive species, soil health, and income security.

Output 2.1.1: (at least 4 nurseries including native and non-invasive commercial species at USD 400,000) delivers community-managed nurseries at approximately USD 100,000 per nursery, a cost-effective infrastructure investment that generates sustained planting stock supply for 8,000 ha of restoration activities under Output 1.1.4 while simultaneously providing ongoing income for women and Indigenous community members. Government-operated state forest nurseries in Kerala and Tamil Nadu typically operate at a capital cost of USD 150,000–300,000 per facility, confirming the cost efficiency of the project's community enterprise model. At an indicative production cost of USD 0.50–1.00 per native seedling, the 4

nurseries would produce sufficient stock for approximately 200–400 ha of restoration planting per year, reducing per-hectare nursery costs for Output 1.1.4 by an estimated 30–40% compared to purchasing from commercial suppliers.

Output 2.1.2: (4,000 ha invasive species clearance and composting at USD 1,400,000) delivers invasive species removal at approximately USD 350 per hectare and establishes approximately 20 composting enterprises converting Lantana biomass into productive organic compost via TNAU Biomineralizer (Tamil Nadu) and KAU microbial consortia (Kerala). Lantana compost is channeled into soil restoration across approximately 3,000 ha of horticultural landscapes. Conventional chemical herbicide-based invasive species control programmes in Indian forest landscapes are documented at costs of USD 200–500 per hectare with no productive output, the project's approach delivers equivalent or superior clearance outcomes while generating compost valued at approximately INR 3,000–5,000 per tonnes creating a self-reinforcing economic model that offsets clearance costs. The systematic use of TNAU-processed Lantana compost for organic mulching across Nilgiris horticultural landscapes directly addresses key drivers of topsoil loss and surface runoff, central to the region's wet-drought dynamics. While restoring the natural forest sponge function and generating measurable hydrological co-benefits alongside livelihood gains from composting enterprises. Each of the approximately 20 composting enterprises (at USD 15,000 each) is projected to generate INR 3–5 lakh per year in compost sales, providing a sustainable post-project income stream without project subsidy. New analysis of 320 adaptation investments across 12 countries finds that every USD 1 invested in adaptation and resilience generates more than USD 10.50 in economic, social, and environmental benefits over a ten-year period, with disaster risk management and nature-based solution investments among the highest-returning categories (WRI, 2025).

Output 2.1.3: (land-based livelihood training and equipment support for approx. 2,000 households at USD 1,000,000) delivers livelihood enterprise support at approximately USD 500 per household, a cost-effective rate for enterprise establishment, market linkage facilitation, and agroforestry systems generating sustained income without requiring land ownership. This is particularly significant for Paniya, Kattunayaka, and Cholanaiikka communities facing insecure land tenure, where conventional agricultural investments requiring land ownership are not accessible. For comparison, government livelihood support programmes under MGNREGS deliver approximately INR 10,000–15,000 per household per year in wage income, equivalent to USD 120–180, without enterprise development or market linkage. The project's enterprise-based approach targets sustained annual household income of INR 30,000–60,000 from composting, nursery, and NTFP enterprises, a 2–5 times improvement on MGNREGS baseline income, at a one-time investment of USD 500 per household.

Component 3: Water Security and Hydrological Resilience (Budget: USD 1,850,000, approx. 12% of grant)

Component 3 addresses climate-driven hydrological stress as a distinct and dedicated adaptation investment, rehabilitating approximately 150 decentralised water systems across 4 target districts at an average cost of approximately USD 12,333 per system. Rehabilitated spring-sheds and decentralised water systems, delivered through rooftop well-recharge systems at approximately ₹5,000–8,000 per household using the Mazhapolima model proven in Kerala hill districts and ferro-cement community tanks at approximately ₹6–7 per litre of storage capacity using the VARSHA/KWA model in Tamil Nadu, further reduce seasonal water scarcity and increase community adaptive capacity. High resolution hydrogeological mapping of drying traditional springs across the upper montane catchments of Wayanad and the Nilgiris plateau will guide precise site prioritisation, ensuring that rehabilitation investments are directed to springs with the greatest hydrological significance for the Bhavani, Chaliyar, and Kabani river systems and the highest potential for recharge recovery. Spring-shed rehabilitation in comparable Indian hill contexts has been documented at a capital cost of under ₹1,00,000 per spring, with interventions including contour trenches, percolation pits, and recharge zone protection, the same suite of measures proposed under Output 3.1.1, confirming the cost defensibility of the project's water systems budget.

For reference, piped water supply schemes in rural Kerala and Tamil Nadu hill districts are documented at a capital cost of USD 200,000–500,000 per village served, compared to the project's decentralised approach at USD 12,333 per system serving an estimated 10–20 households, a cost reduction of 60–80% per household served while achieving equivalent or superior climate resilience outcomes through community-managed, hydrologically integrated systems. The deployment of decentralised rainwater harvesting storage networks, percolation pits, and soil-moisture monitoring tools in rainfed smallholder areas further enhances cost-effectiveness by capturing high-velocity monsoon runoff before it escapes degraded slopes, directly addressing farm-level seasonal water deficits at significantly lower cost than conventional irrigation infrastructure. MGNREGS co-financing at a 90:10 ratio applies to eligible percolation pits and rainwater harvesting structures, further reducing effective project cost. A projected freshwater deficit of 214 MCM by 2040 in the Chaliyar basin and the documented burden of women spending 2–3 additional hours per day collecting water during droughts provide the quantified cost-of-inaction baseline against which this investment should be assessed. Community water user groups established with gender-balanced governance and Indigenous Peoples representation generate post-project sustainability at no additional cost to the project, ensuring water systems remain operational and equitably managed beyond the project period.

Component 4: Empowered Local Self-Governments in Climate and Biodiversity Governance + Climate Finance Mobilization (4A) (Budget: USD 1,050,000, approx. 7% of grant)

Component 4 focuses on embedding climate resilience and ecosystem-based adaptation into the statutory functions of Local Self-Governments, anchored by a State Training Centre for EbA with the Kerala State Biodiversity Board leading training of 13,200 members across 1,200 Biodiversity Management Committees. At a governance and capacity building budget of USD 700,000 for Outputs 4.1.1 and 4.1.2, this translates to an indicative cost of approximately USD 53 per BMC member trained, compared to a government-operated training cost of approximately USD 80–120 per person under formal state capacity building programmes, confirming the cost efficiency of the project's State Training Centre model. The Training Centre itself, once established, generates recurring capacity building outcomes at zero marginal cost to the project beyond the initial investment, serving as a self-sustaining institutional asset post-project. By training diverse stakeholders, including Panchayat representatives, women's SHGs, Biodiversity Management Committees, Farmer Producer Organisations, and Indigenous councils, the project institutionalises locally led adaptation. Capacity-building on climate-informed planning, budgeting, and monitoring reduces the need for repeated external interventions, enhancing cost-effectiveness. Cross-departmental coordination and knowledge-sharing platforms increase operational efficiency, avoid duplication, and facilitate scaling of best practices across the corridor. At least 20 LSGs integrating EbA into annual budgets and development plans represent a leverage ratio of approximately USD 35,000 per LSG for institutional mainstreaming, a cost-effective investment given that each LSG budget averages INR 2–5 crore per year, meaning successful EbA integration could redirect INR 20–50 lakh per LSG per year toward climate-resilient investments at no additional cost to the project. Integration of gender-responsive and socially inclusive measures, supporting women-led and Indigenous enterprises, and access to climate and disaster risk finance, further strengthens economic and social resilience, multiplying the benefits of investment across multiple sectors.

Component 4A: (Climate Finance Mobilisation at USD 350,000 across Outputs 4.2.1–4.2.2) designs and pilots at least 2 blended finance mechanisms, a potential leverage ratio of approximately 11–17 times the enabling investment, consistent with blended finance benchmarks for climate adaptation in South Asia. The mechanisms build on existing local biodiversity funds already operational across 4 districts and delivering small grants and loans to approximately 500 farmers, Indigenous community members, and women-led enterprises, addressing the market failure in rural credit access that leaves smallholders and Indigenous Peoples without enterprise capital. Parametric risk transfer instruments and crop/livestock insurance mechanisms designed for at least 500 women-headed and Indigenous Peoples households provide post-project financial resilience at a design cost of approximately USD 700 per household covered, generating ongoing risk protection at no recurring project cost.

Overall assessment: The NWC project demonstrates high cost-effectiveness by combining targeted interventions in land-use planning, Eco-DRR, invasive species management, dedicated water security, nature-based livelihoods, and governance. Upstream ecosystem restoration protects downstream communities, reducing the need for expensive reactive infrastructure. The regional approach spanning Kerala and Tamil Nadu allows pooling of technical expertise, operational efficiencies, and knowledge exchange, maximising returns on investment. The budget structure confirms approximately 74% of the grant directed to direct adaptation investments (Components 1, 2, and 3) and approximately 26% to enabling activities (Component 4 including 4A and Component 5), in line with Adaptation Fund requirements. In aggregate, the project delivers: vulnerability mapping across 4 districts at USD 50,000 per district; slope stabilisation structures at 40–60% of grey infrastructure equivalent costs; early warning coverage for 10,000–15,000 households at USD 3,000–5,000 per LEWS system, aligned with a globally benchmarked 1:9 cost-benefit ratio; invasive species clearance and composting at USD 350 per hectare generating self-sustaining enterprise income; ecosystem restoration across 8,000 ha at approximately USD 512 per hectare consistent with Western Ghats restoration evidence; decentralised water security at ₹5,000–8,000 per household and under ₹1,00,000 per spring, 60–80% cheaper than piped water alternatives; land-based livelihoods training support for 2,000 households at USD 500 per household delivering 2–5 times improvement on MGNREGS baseline income; and institutional capacity building at approximately USD 53 per BMC member.

Collectively, these interventions reach an indirect beneficiary population of 1.5–2 million people at an indicative cost of USD 7.50–10 per person in the indirect benefit zone, consistent with adaptation investment benchmarks in the literature. The blended finance component targets a leverage ratio of 11–17 times the enabling investment, ensuring climate adaptation is sustained and scaled beyond the project period at no additional cost to the Adaptation Fund. By integrating environmental restoration, disaster risk reduction, livelihood diversification, and institutional strengthening, the project provides a sustainable, scalable, and economically sound model for climate adaptation in the Nilgiri–Wayanad Corridor.

E. Consistency with national or sub-national sustainable development strategies

Strategies	Description	Relationship with the project
<i>National Action Plan on Climate Change (NAPCC, 2008)</i>	India's overarching framework for climate resilience, comprising eight national missions, including sustainable agriculture, sustainable habitat, and energy efficiency. It provides guidance for integrating adaptation, mitigation, and ecosystem restoration measures across sectors.	The NCC project operationalizes multiple NAPCC missions: NMSA for climate-smart agriculture in Wayanad and Nilgiris, NMSH for urban resilience in Coimbatore and Kozhikode, and GIM for forest restoration, ensuring the corridor's interventions align with national climate and development priorities.
<i>National Mission for Sustainable Agriculture (NMSA, 2010)</i>	Focuses on climate-resilient agriculture, soil and water conservation, and promotion of adaptive practices for high-priority crops such as coffee, tea, and spices.	The project implements shade-grown coffee agroforestry, millet/tuber cultivation, and other climate-resilient cropping systems in Wayanad and Nilgiris, strengthening food security and smallholder livelihoods under erratic rainfall conditions.
<i>National Mission on Sustainable Habitat (NMSH, 2015)</i>	Guides urban resilience strategies through energy efficiency, sustainable waste management, and the Climate Smart Cities Assessment Framework.	The project integrates NMSH priorities in Coimbatore and Kozhikode by promoting climate-informed land-use planning, decentralized water management, and nature-based solutions for urban flood mitigation and energy-efficient practices.
<i>Green India Mission (GIM, 2014)</i>	Targets afforestation, ecosystem restoration, and biodiversity conservation to enhance carbon sinks and ecosystem services.	The NCC project restores approximately 8,000 hectares of degraded landscapes, establishes biodiversity corridors in Nilgiri-Wayanad, and protects sacred groves and wetlands, directly contributing to GIM objectives.
<i>National Water Mission (2011)</i>	Aims to ensure integrated water resource management, improve water-use efficiency, and address projected freshwater deficits.	Community-led watershed interventions, spring-shed rejuvenation, and riverbank stabilization in the Chaliyar Basin support NWM goals, mitigating projected deficits of 214 MCM by 2040 and enhancing water security.
<i>National Biodiversity Action Plan (NBAP, 2021–2030)</i>	Provides India's framework for biodiversity conservation, ecosystem restoration, and sustainable use of natural resources, aligned with the Kunming–Montreal Global Biodiversity Framework.	The project integrates biodiversity conservation into climate adaptation by restoring shola-grassland ecosystems, protecting OECMs, and creating ecological corridors, supporting both national and global biodiversity commitments.
<i>Nationally Determined Contributions (NDC, India, 2021)</i>	India's Paris Agreement commitment emphasizes reducing emissions intensity, creating additional carbon sinks, and scaling up adaptation measures in agriculture, forestry, and water management.	The project contributes to NDC targets by creating carbon sinks through agroforestry and forest restoration, operationalizing climate adaptation in agriculture and water resources, and promoting sustainable lifestyles via Mission LiFE pilots.
<i>Mission LiFE (Lifestyle for Environment)</i>	Promotes sustainable lifestyles and circular economy initiatives to reduce emissions and enhance local climate action.	The project pilots community-led carbon neutrality initiatives, tree banking, renewable energy adoption, and circular economy projects such as Lantana briquetting to operationalize Mission LiFE principles at the landscape level.
<i>State Action Plan on Climate Change (SAPCC 2.0, Kerala, 2023–2030)</i>	Identifies Wayanad, Kozhikode, and Malappuram as high-priority zones for ecosystem-based adaptation, decentralized planning, and climate risk reduction.	The project embeds Eco-DRR, watershed management, and participatory planning into local Panchayat Development Plans, operationalizing SAPCC 2.0 objectives at the district and LSG level.
<i>Rebuild Kerala Initiative (RKI, 2018)</i>	Focuses on post-flood recovery, risk-informed land-use planning, and river basin management for Kerala's high-risk districts.	NCC activities in Wayanad, Kozhikode, and Malappuram integrate RKI approaches through landslide mitigation, slope stabilization, and basin-level water management.
<i>Haritha Keralam Mission (2016)</i>	Aims to conserve water resources, promote organic farming, and ensure	The project aligns with Haritha Keralam by rehabilitating springs, promoting rainwater

	sustainable waste management across Kerala.	harvesting, and supporting organic and climate-resilient farming practices in highland landscapes.
<i>State Biodiversity Strategy and Action Plan (K-SBSAP, 2025–2035)</i>	Guides Kerala's conservation priorities, including sacred groves and other effective area-based conservation measures (OECMs).	The project protects and restores sacred groves, wetlands, and fragmented habitats while creating nurseries (including native and non-invasive commercial species), aligning with state biodiversity objectives.
<i>Tamil Nadu Climate Change Mission (TNCCM)</i>	Prioritizes adaptation in ecologically fragile regions such as the Nilgiris, including conservation of shola–grassland ecosystems and biodiversity restoration.	The project implements habitat restoration, invasive species control, and climate-informed planning in Nilgiris, supporting TNCCM goals for ecosystem resilience and climate adaptation.
<i>Tamil Nadu State Action Plan on Climate Change (TNSAPCC)</i>	Provides high-resolution risk assessments and adaptation planning for agriculture, forestry, and water resources at the district level.	The project uses climate and hazard data to inform district-level adaptation strategies in Nilgiris, Coimbatore, and Erode, aligning interventions with TNSAPCC priorities.
<i>Green Tamil Nadu Mission (GTNM)</i>	Focuses on restoring degraded lands, promoting native vegetation, and controlling invasive species across Tamil Nadu.	The project restores degraded landscapes, establishes biodiversity corridors, and implements invasive species management in Nilgiris and Coimbatore, contributing to GTNM objectives.
<i>Nationally Determined Contributions (NDC, India, 2021)</i>	India's Paris Agreement commitment emphasizes reducing emissions intensity, creating additional carbon sinks, and scaling up adaptation measures in agriculture, forestry, and water management.	The project contributes to NDC targets by creating carbon sinks through agroforestry and forest restoration, operationalizing climate adaptation in agriculture and water resources, and promoting sustainable lifestyles via Mission LIFE pilots.
<i>Sendai Framework for Disaster Risk Reduction (2015–2030)</i>	Global framework to reduce disaster risk through proactive risk assessment, preparedness, and resilient infrastructure planning.	Component 1 interventions, landslide hazard mapping, Eco-DRR, and early warning systems, directly operationalize Sendai priorities at the district and local government level. The project further adheres to the National Disaster Management Plan (NDMP) 2019, which provides the overarching framework for disaster risk reduction in India across prevention, mitigation, preparedness, response, and recovery phases. The composite vulnerability maps, localized early warning systems, and slope bioengineering measures under Component 1 directly align with NDMP 2019 priorities for multi-hazard risk profiling, community preparedness, and nature-based mitigation. All project activities relating to disaster risk governance are designed in compliance with the Disaster Management Act, 2005, including integration of outputs into District Disaster Management Plans and coordination with State Executive Committees and District Disaster Management Authorities as mandated under the Act.
<i>Sustainable Development Goals (SDGs, UN, 2015)</i>	Global framework covering poverty reduction, climate action, water security, and biodiversity conservation. Relevant goals include SDG 1, 2, 5, 6, 13, and 15.	Project activities advance SDGs by strengthening food security, water management, climate-resilient agriculture, ecosystem restoration, and gender-inclusive governance, ensuring multiple co-benefits for vulnerable communities.

The project is designed to achieve systematic convergence with relevant national and state programmes across agriculture and food security (NMSA, PM-KISAN), natural resource management (CAMPA, Green India Mission), rural livelihoods (MGNREGS, NRLM), watershed development (PMKSY, Integrated Watershed Management Programme), tribal and Indigenous Peoples development (TRIFED, Van Dhan Vikas Kendras, PVTG Mission), and state-led ecosystem restoration initiatives (including State Biodiversity Board programmes, Haritha Keralam Mission, and Green Tamil Nadu Mission). Rather than operating as a standalone intervention, the project will build upon and strengthen existing government

programmes, using Adaptation Fund resources to catalyse investments, promote co-financing, and support integrated landscape-scale implementation. Detailed convergence arrangements, including joint planning mechanisms and shared monitoring frameworks with relevant schemes and institutions, will be developed and formalized during the full proposal stage.

F. Compliance with national technical standards and AF Environmental and Social Policy

Regulation / Standard	Description	Adherence in the NCC Project	AF Policy
<i>Environment Impact Assessment (EIA) Notification, 2006</i> ⁷	India's statutory process for assessing environmental impacts of proposed activities, ensuring sustainability and mitigation of negative effects.	Project interventions (watershed works, land treatments, water systems) are subject to screening/assessment under EIA processes where applicable, and an Environmental and Social Management Plan (ESMP) will be prepared.	Environmental assessment; Protection of natural habitats
<i>Environment (Protection) Act, 1986</i> ⁸	Provides the central legal framework for environmental quality, pollution control, and environmental safeguards.	Project design adheres to the principles of environmental protection, ensuring compliance with pollution prevention and ecosystem safeguards in all components.	Environmental and social safeguards
<i>Forest (Conservation) Act, 1980 and Compensatory Afforestation Fund Act, 2016</i> ⁹	Regulates diversion of forest land, mandates conservation, and administers compensatory afforestation.	Restoration activities, invasive species removal, and native ecosystem regeneration follow legal requirements for forest conservation and contribute to afforestation obligations without compromising protected forest lands.	Conservation of biological diversity; Land and soil conservation
<i>Wildlife (Protection) Act, 1972</i> ¹⁰	Legal protection for wildlife and habitats, regulating activities that affect fauna and ecological corridors.	Non-invasive human-wildlife coexistence measures (e.g., deterrents, monitoring) avoid harmful infrastructure and respect protected species/habitat norms.	Protection of natural habitats; Human-wildlife safeguards
<i>National Water Policy (2012)</i> ¹¹	Guides integrated water resources management, conservation, and equitable distribution.	Spring-shed rejuvenation, decentralized water harvesting, and basin-level planning directly support integrated water resource principles.	Water security; Risk reduction
<i>National Mission for Sustainable Agriculture</i> ¹²	Sets standards for climate-resilient agriculture, soil and water conservation, and adaptive crop systems.	Climate-resilient farming practices (shade-grown agroforestry, millets), soil and water conservation align with NMSA guidance.	Sustainable livelihoods; Climate resilience
<i>National Biodiversity Strategy and Action Plan (NBSAP)</i> ¹³	Framework for biodiversity conservation, ecosystem restoration, and sustainable use of biological resources.	Restoration of native ecosystems, biodiversity corridors, and assisted regeneration supports national biodiversity goals.	Conservation of biological diversity; Ecosystem protection
<i>Kerala SAPCC 2.0 (2023–2030)</i> ¹⁴	State climate action framework prioritizing ecosystem-based adaptation and decentralized planning.	Eco-DRR, participatory planning, watershed management, and climate-informed land use operationalize SAPCC priorities in	Climate-resilient planning; Inclusive governance

⁷ <https://environmentclearance.nic.in/writereaddata/EIA%20Notifications.pdf>

⁸ https://www.indiacode.nic.in/bitstream/123456789/4316/1/ep_act_1986.pdf

⁹ <https://www.indiacode.nic.in/bitstream/123456789/2151/1/A2016-38.pdf>

¹⁰ https://www.indiacode.nic.in/bitstream/123456789/6198/1/the_wild_life_%28protection%29_act%2C_1972.pdf

¹¹ https://nwm.gov.in/sites/default/files/national%20water%20policy%202012_0.pdf

¹² <https://nmsa.dac.gov.in/>

¹³ <http://nbaindia.org/nbsap/index.html>

¹⁴ <https://moef.gov.in/uploads/2017/09/KERALA-STATE-ACTION-PLAN-ON-CLIMATE-CHANGE.pdf>

		Wayanad, Kozhikode, and Malappuram.	
<i>Tamil Nadu Climate Change Mission and Green Tamil Nadu Mission¹⁵</i>	State strategies for adaptation in ecologically fragile regions and ecosystem restoration.	Ecosystem restoration, invasive species control, and climate adaptation planning in Nilgiris, Coimbatore, and Erode are consistent with these missions.	Ecosystem resilience; Climate adaptation
<i>Eco-Sensitive Zone Regulations</i>	Central guideline for buffer zones around protected areas to regulate activities and protect ecosystems.	Project activities are planned to avoid negative impacts in notified eco-sensitive regions by using risk-informed planning and nature-based solutions.	Protection of natural habitats; Biodiversity safeguards
<i>Adaptation Fund Environmental and Social Policy</i>	International safeguard framework requiring gender equity, inclusion, FPIC, protection of Indigenous and vulnerable groups, and participatory monitoring and accountability.	Project adopts FPIC with indigenous groups (e.g., Kattunayaka, Paniya), mandates 50% women participation, prioritizes vulnerable households, and integrates participatory MandE and social audits.	Gender equity; Indigenous Peoples; Stakeholder engagement; Accountability
<i>Labour and Occupational Safety Standards (e.g., Building Codes)</i>	National standards ensuring safe working conditions, non-discrimination, and compliance with infrastructure norms.	Construction and field works incorporate occupational health, safety measures, and inclusive labour practices in line with national standards.	Workplace safety; Non-discrimination
<i>Constitution of India – Articles 14, 15, 16, 46, 330, 332</i>	Provides equality before the law, prohibits discrimination based on sex, and promotes educational, economic, and political participation of Scheduled Tribes and other marginalized groups. Articles 330/332 ensure reserved political representation for SC/ST communities.	The project ensures participation of women in all trainings and governance platforms, and engages indigenous groups, Gram Sabhas under FPIC processes for resource management and adaptation planning.	Gender equality and women's empowerment; Indigenous Peoples' rights; Access and equity
<i>Panchayats (Extension to Scheduled Areas) Act (PESA), 1996</i>	Grants self-governance and decision-making authority to Gram Sabhas in Scheduled Areas over natural resources, development projects, and local planning.	The NCC project coordinates with Gram Sabhas to integrate ecosystem-based adaptation plans, natural resource management, and restoration interventions, ensuring FPIC and community ownership.	Indigenous Peoples' rights; Free, Prior, and Informed Consent; Participatory governance

G. Duplication of project/programme with other funding sources, if any

There is no expected duplication with other projects in the area. The table below details the complementarity of this regional project with other initiatives in both countries.

Relevant project	Description	Relevance and complementarity with the proposed project
<i>Western Ghats Watershed Development Projects</i>	Government-led watershed interventions implemented under several state (e.g., Haritha Keralam Mission ¹⁷ watercourse rejuvenation) and national schemes have focused on restoring water networks,	These efforts provide a foundational understanding of local hydrology, community engagement mechanisms, and water resource interventions at the Panchayat level. The NCC project can leverage existing

¹⁵ <https://tnclimatechangemission.in/home/>

¹⁷ <https://haritham.kerala.gov.in>

<i>(State and Central programmes)¹⁶</i>	reclaiming streams, improving irrigation tanks and water channels, and enhancing soil and moisture conservation in Western Ghats catchments. These programmes conducted large-scale mapping, watercourse cleaning, embankment rehabilitation, and participatory local watershed management actions across Gram Panchayats in Western Ghats districts.	watershed maps, community committees, and technical insights to scale integrated source-sink restoration, spring-shed recharge designs, and decentralized water systems across the corridor while avoiding duplication by aligning with and enhancing ongoing water conservation actions in targeted sub-basins.
<i>Wayanad Conflict Mitigation Project¹⁸</i>	A landscape-level human–wildlife conflict mitigation initiative in the Nilgiri Plateau (Wayanad district), involving frontline response teams, livestock protection, anti-snare patrols, and collaboration between forest departments and local communities to reduce negative interactions between people and large mammals.	The proposed NCC project complements this by strengthening climate-resilient coexistence systems (habitat restoration, conflict risk information services, corridor management) at larger spatial scales. The NCC will not duplicate local conflict response but will build on early mitigation results, integrating them into broader risk assessments, coordinated wildlife corridor support, and community-based early warning systems as part of Component 2.
<i>State-level ecological restoration and greening missions (e.g., Green Tamil Nadu Mission palmyra restoration)</i>	Large-scale ecological restoration and afforestation programmes implemented by state agencies expanded native tree planting, groundwater recharge planting, and community participation to build ecosystem resilience and sequester carbon through nature-based restoration.	The NCC project will complement these restoration drives by focusing on restoration anchored in climate risk reduction (e.g., slope stabilization, invasive species removal, and shola–grassland connectivity) rather than general afforestation alone. Lessons on large-scale seed dibbling, community participation mechanisms, and geotagging efforts will inform nursery networks and landscape restoration protocols under Component 1 and 2.
<i>Navakeralam Karma Padhathi / Haritha Keralam Mission watercourse reclamation campaign¹⁹</i>	Kerala’s state programme that has mapped and initiated reclamation of watercourses in Western Ghats Panchayats, including scientific mapping, local committees, and participatory stream restoration measures to improve water flow, enhance drainage, and restore catchment hydrology.	These actions provide detailed watercourse maps, community task forces, and governance models that the NCC project can adopt and scale up within a corridor watershed context. The project can build on this foundation for hydrological data, integrate localized water management into GDPs and district disaster plans, and expand spring recharge and decentralized water governance systems without duplicating the original mapping effort.
<i>Agasthyavanam Project (Agasthyavanam Biological Park ecological restoration)</i>	An earlier eco-restoration and biodiversity conservation initiative in the southern Western Ghats focused on improving degraded forest landscapes through afforestation, species reintroduction, and eco-conservation within the Agasthyamala Biosphere. (Wikipedia)	While spatially outside the NCC’s immediate focus, this project’s ecosystem regeneration and biodiversity recovery approaches offer important lessons on integrated restoration design, species selection, and community engagement in forest regeneration. The NCC project will adapt these ecological insights for corridor-specific habitats (e.g., shola–grasslands) to strengthen restoration strategies under Component 1 and 2.

¹⁶ <https://www.naturefuture.org/projects/restoring-natural-habitat-western-ghats>

¹⁸ <https://www.wti.org.in/projects/wayanad-conflict-mitigation-project/>

¹⁹ <https://haritham.kerala.gov.in/structure.php>

H. Learning and knowledge management component to capture and disseminate lessons learned.

The project's corridor-level focus allows for the integration of a diverse set of ecosystem-based adaptation and community-led solutions, fostering innovation and the exchange of lessons among local institutions, community organizations, and government agencies. Mutual learning is anticipated, for instance, from successful watershed restoration and climate-resilient livelihood models implemented in other parts of India, which can inform the design of restoration-linked employment, water management interventions, and biodiversity-linked enterprises in the NCC. Conversely, the project's pioneering approaches, such as integrating indigenous knowledge, women's leadership in restoration, and participatory monitoring of springsheds and forest corridors, can provide lessons for replication in other biodiversity-rich hill ecosystems across India. Regional dialogues and workshops with neighboring states and national institutions will facilitate cross-learning, particularly in linking ecosystem restoration with community resilience and conflict mitigation. Partnerships are already being established with research institutions, universities, and NGOs to share best practices in ecosystem-based adaptation, restoration-linked livelihoods, and invasive species management.

In addition, the project will contribute to strengthening state-level and national climate adaptation knowledge systems by developing open-access digital platforms, climate resilience dashboards, and repositories of ecosystem-based adaptation tools. These platforms will consolidate data on localized climate risks, hydrological monitoring, restoration outcomes, and livelihood interventions. The project's capacity-building efforts, combined with on-the-ground restoration and watershed management activities, will ensure that lessons from ecosystem restoration, watershed management, and soil and water conservation are systematically documented and fed into planning processes at the local and state levels. Particular attention will be given to capturing lessons related to gender-inclusive planning, participation of Indigenous Peoples, and women-led enterprises, reinforcing the evidence base for inclusive climate adaptation.

The project will establish a structured knowledge management framework, led by a dedicated Monitoring, Evaluation, and Learning (MEL) officer within the Project Management Unit (PMU), to oversee continuous capture, documentation, and dissemination of lessons. The PMU, together with the project Steering Committee, will ensure that outputs from Components 1 and 2 are published as detailed case studies, field notes, and village adaptation maps. These will be integrated into regional knowledge hubs, linked to national platforms such as state climate cells and relevant central ministries, and shared with global networks including UNEP's CityAdapt and other EbA knowledge platforms.

Knowledge dissemination under component 3, will employ multiple channels, including localized videos, field guides, workshops, and exchange visits, to ensure accessibility for indigenous groups and rural communities. Horizontal learning networks will promote peer-to-peer exchange between Gram Panchayats, watershed committees, and Farmer Producer Organizations (FPOs), enabling the replication of successful restoration-linked livelihood models, carbon-neutral initiatives, and conflict-mitigation approaches across the corridor. The continuous learning process embedded in Component 10, supported by the knowledge management framework, will ensure that the evidence and lessons generated by the project are not only applied locally but also inform national and regional climate adaptation policies, strategies, and programs.

I. Consultative process, including the list of stakeholders consulted

During the design of the Concept Note, stakeholder consultations were conducted in the states of Kerala and Tamil Nadu, India, focusing on the NWC. As part of the proposal development, state-level preparation meetings were held both virtually and in-person between January 22 and February 3, 2026, during which key stakeholders were mapped and potential climate and socio-ecological risks identified across districts including Wayanad, the Nilgiris, Malappuram, and Coimbatore. The consultations aimed to collect basin-level baseline information on climate hazards such as landslides, extreme rainfall, forest fragmentation, and hydrological stress, as well as gender-specific information related to the disproportionate burden of water collection and agricultural labor.

Figure 5: Stakeholder engagement on ground

In Kerala, a state-level stakeholder meeting engaged 41 participants from various departments, highlighting the corridor's high vulnerability due to geographic fragility and ecological sensitivity. A district-level workshop in Kalpetta, Wayanad, convened 77 participants, who emphasized the historical transition from "*Vayal Nadu*" (land of paddy) to cash-crop agriculture. During these workshops, Participatory Rural Appraisal (PRA) tools, including problem ranking, social and resource mapping, seasonal calendars, and historical timelines, were applied to identify root causes such as forest degradation, declining groundwater, soil erosion, and invasive species proliferation. These findings directly informed the problem tree and theory of change of the proposed project. Solutions identified included ecosystem restoration,

management of invasive species such as *Lantana* and *Senna*, slope stabilization, and female empowerment through community-led groups such as Haritha Samitis and restoration-linked enterprises like Lantana briquetting units.

In Tamil Nadu, a state-level consultation in Chennai brought together over 100 participants, describing the Western Ghats as the “backbone of climate action” due to their critical role in regulating water and biodiversity. Community-level discussions in Gudalur, Ooty, and Coimbatore identified risks such as human-wildlife conflict, erosion, spring depletion, and the disappearance of traditional medicinal plants. One key barrier reported by stakeholders, particularly landless households and indigenous groups, was the lack of formal land titles, which restricts access to institutional credit, crop insurance, and government compensation for disaster-related losses. Extreme weather events were also noted to cause power and communication disruptions, limiting emergency response and service delivery. Given the corridor’s transboundary and remote nature, consultations were carried out through a mix of district-level workshops, field visits, focused interviews, and FGDs, ensuring inclusion of Indigenous groups such as the Paniya, Kattunayaka, Kuruma, and Cholanaiika. Participation followed Free, Prior, and Informed Consent (FPIC) protocols, ensuring culturally appropriate and voluntary engagement. Representation of women and men was guaranteed in all sessions, involving stakeholders from custodian farmers, NGOs, forest officials, local governments, and academic institutions.

These consultations provided critical inputs that shaped the project’s integrated landscape-level interventions, prioritizing both ecosystem integrity and social inclusion, including climate-resilient water management, ecosystem-based adaptation, human-wildlife conflict mitigation, livelihood diversification, and gender-responsive planning. In addition, stakeholders highlighted systemic barriers, such as youth out-migration, labor precarity, and limited access to climate information, which informed the design of capacity-building, decentralized governance, and risk-sharing components of the project. Key contributors during the design phase included state departments of agriculture, forestry, and disaster management, the Tamil Nadu Green Climate Company, Kerala State Disaster Management Authority, and elders and representatives of indigenous communities, ensuring that the project reflects local priorities, ecological realities, and social equity considerations.

The Kerala State Disaster Management Authority (SDMA), which participated in the state-level consultation on 23 January 2026, identified ecosystem degradation, including invasive species proliferation, forest degradation, water scarcity, and human–wildlife conflict, as a critical gap in current disaster risk reduction efforts, despite improvements in early warning systems and evacuation planning. The SDMA also emphasized the need to strengthen local government capacities to access and utilize existing disaster risk reduction and mitigation funds for nature-based adaptation. These recommendations informed the design of community-level early warning systems (Output 1.1.3), ecosystem restoration interventions to reduce disaster risk (Output 1.1.4), and the blended finance mechanisms under Component 4A. Similarly, during the Tamil Nadu state-level consultation on 27 January 2026, stakeholders highlighted the importance of strengthening disaster preparedness and early warning systems for landslides and extreme rainfall events, with particular attention to last-mile connectivity in high-risk areas. During full proposal development, dedicated consultations will be undertaken with the SDMA and District Disaster Management Authorities (DDMAs) of Kerala and Tamil Nadu to map ongoing NDMA-supported initiatives, ensure alignment with state and district disaster management plans, and avoid duplication with existing hazard-specific programme.

The stakeholder consultation itinerary for the project is outlined below. (this will be gender disaggregated)

Date	Location	Activity	Attendance	Participants / Mode of participation
Jan 22	Virtual	State-level Preparation Meeting: Tamil Nadu	(Not specified)	Tamil Nadu government officials
Jan 23	Virtual	Consultation 1: State-level Stakeholder Meeting: Kerala	41	State Government: Kerala State Biodiversity Board, State Disaster Management Authority, Sectoral Departments (Agriculture, Coffee, Livestock, Spices, Irrigation, Water Resources)
Jan 27	Chennai	Consultation 2: Joint State- and District-level Workshop (Participants from Nilgiris and Coimbatore)	Over 100	State Government: Tamil Nadu Green Climate Company, Forest Department (including Mudumalai restoration unit), Various State Departments and Research Organizations Civil Society: NGOs and community representatives
Jan 28	Transit	Travel to Kozhikode	-	
Jan 29	Wayanad	Travel to Kalpetta; Field visit and community FGD with Indigenous/vulnerable groups (Afternoon)	28	Civil Society / Community: Indigenous groups (Paniya, Kattunayaka, Kuruma, Cholanaiika), Smallholder and Custodian Farmers; Women-led groups: Haritha Samitis

Jan 30	Wayanad	Consultation 3: District-level Stakeholder Meeting (Kerala Districts) in Kalpetta	77 (Officials)	Local Government: District officials (Wayanad, Nilgiris, Malappuram)
Jan 31	Gudalur	Community-level consultations	(See below)	Civil Society / Community: Indigenous groups, Women's Groups (Lantana briquetting units), Smallholder farmers; consultations included FGDs and field workshops
Feb 1	Ooty	Community-level consultations	(See below)	Civil Society / Community: Indigenous groups, smallholder farmers; FGDs and consultation meetings
Feb 2	Coimbatore	Community-level consultations	(See below)	Civil Society / Community: Indigenous groups, smallholder farmers; FGDs and consultation meetings
Feb 3	Transit	Travel from Coimbatore to Delhi	-	-

Key Attendance and participant profiles

- *State level (Kerala, Jan 23)*: 41 participants including state departments, technical agencies, and the Kerala State Biodiversity Board.
- *State level (Tamil Nadu, Jan 27)*: Over 100 participants including officials from Tamil Nadu Green Climate Company, Forest Department, research organizations, and civil society representatives.
- *District level (Wayanad, Jan 29–30)*: 77 district officials addressed land-use change, agriculture, and governance challenges, while 28 community members participated in a dedicated FGD.
- *Community level Consultations (Jan 31–Feb 2)*: Focused on indigenous groups (Paniya, Kattunayaka, Cholanaika) and smallholder farmers to understand priorities related to water security, human–wildlife coexistence, and climate-adaptive livelihoods. Women's groups and local enterprises (e.g., Lantana briquetting units) were actively involved.

J. Justification for funding requested, focusing on the full cost of adaptation reasoning

The requested funding of USD 15,000,000 represents the minimum necessary to deliver the full adaptation outcomes envisioned for the NWC. This amount is structured to prioritize direct climate adaptation investment, with at least 80% directed to direct adaptation investments and a maximum of 20% to enabling activities, in line with Adaptation Fund requirements.

Budget Head	Amount (USD)	% of Grant	Justification
Component 1: Integrated Climate Risk Assessment and Eco-DRR (<i>Direct, Outcome 1.1</i>)	6,500,000	43%	Composite vulnerability mapping across 4 districts embedded into 20 GDPDs and 4 DDMPs; slope bioengineering in 2 montane districts (500–700 vegetative bunds, 50 check dams, 50–70 gabion walls, 200–300 recharge pits); 20 LEWS targeting 10,000–15,000 households; ecological restoration of approximately 8,000 ha of degraded forest, shola–grassland, and wildlife corridor habitats across 10–15 landscape sites. Scale, multi-hazard complexity, and landscape restoration scope justify the largest allocation.
Component 2: Climate-resilient Livelihoods and Invasive Species Management (<i>Direct, Outcome 2.1</i>)	2,800,000	19%	At least 4 nurseries (including native and non-invasive commercial species) managed by Indigenous Peoples and women as community enterprises; approximately 4,000 ha cleared of Lantana camara and Senna spectabilis converted into organic compost via TNAU Biomineralizer (Tamil Nadu) and KAU microbial consortia (Kerala), channeled into soil restoration across approximately 3,000 ha of horticultural landscapes; land-based livelihood training and equipment support for approximately 2,000 women and Indigenous Peoples households through composting enterprises, nursery operations, NTFP value chains, and agroforestry.
Component 3: Water Security and Hydrological Resilience (<i>Direct, Outcome 3.1</i>)	1,850,000	12%	Approximately 150 decentralized water systems rehabilitated or constructed; 40 priority springs, 50 check dams, 30 percolation pits, and 30 rainwater harvesting systems (Mazhapolima model in Kerala; VARSHA/KWA model in Tamil Nadu), across 4 target districts; community water user groups with gender-balanced governance and Indigenous Peoples representation. MGNREGS co-financing at 90:10

			applicable for eligible structures. Dedicated allocation reflects hydrological stress as a distinct climate impact pathway.
Component 4: Empowered LSGs in Climate and Biodiversity Governance + Climate Finance Mobilization (4A) (<i>Enabling, Outcomes 4.1 + 4.2</i>)	1,050,000	7%	State Training Centre for EbA established in Kerala; Kerala State Biodiversity Board training 13,200 members across 1,200 BMCs; EbA toolkits disseminated to at least 20 LSGs; at least 3 cross-state peer learning workshops; digital adaptation platforms with confirmed post-project State Government ownership; at least 2 blended finance mechanisms; local biodiversity funds providing grants and loans without land collateral requirements; parametric insurance for at least 500 women-headed and Indigenous Peoples households;. Deliberately structured to remain within AF 20% enabling cap.
Component 5: M&E and Knowledge Management (<i>Cross-cutting</i>)	425,580	3%	Participatory M&E with sex-disaggregated and Indigenous Peoples-disaggregated data, quantitative targets, adaptive management protocols, baseline survey, mid-term and terminal evaluations, and at least 3 knowledge products disseminated through regional and global EbA platforms.
Subtotal, Direct adaptation investment (<i>Components 1, 2, and 3</i>)	11,150,000	74%	Exceeds AF minimum of 80% of component cost directed to direct adaptation investment.
Subtotal, Enabling activities (<i>Component 4 including 4A</i>)	1,050,000	7%	Well within AF maximum of 20%.
Project Execution Cost (9.5%)	1,199,305	—	Operational and administrative costs for project execution.
Total Project Cost	13,824,885	—	
Implementing Entity Cycle Management Fee (8.5%)	1,175,115	—	Fiduciary oversight, quality assurance, and AF compliance by UNEP.
Total Financing Requested	15,000,000	—	

Baseline scenario (without AF Funding): Without this investment, the NWC will continue experiencing escalating wet-drought cycles, where heavy monsoons trigger catastrophic landslides, as demonstrated by the 2024 Wayanad tragedy (400+ deaths, INR 1,200 crore in losses), while groundwater recharge fails, springs dry earlier each year, invasive species spread unchecked, and wildlife corridors remain severed. A projected freshwater deficit of 214 MCM by 2040 in the Chaliyar basin will deepen water insecurity for 1.5–2 million people downstream. Indigenous Peoples and smallholder farmers, including Paniya, Kattunayaka, and Cholanaikka communities facing insecure land tenure, will remain trapped in cycles of climate-induced poverty and disaster with no anticipatory warning capacity and no access to climate finance or risk transfer instrument

Adaptation alternative (with AF Funding): The proposed funding enables a shift from reactive development to proactive, landscape-scale climate resilience through: 20 community-level LEWS aligned with IMD and NLFC protocols covering 10,000–15,000 households; composite vulnerability mapping across 4 districts embedded into 20 GPDPs and 4 DDMPs prioritizing the highest-need communities; ecological restoration of approximately 8,000 ha across 10–15 priority sites; *Lantana camara* and *Senna spectabilis* removal as core adaptation measures across approximately 4,000 ha with organic compost channeled into soil restoration across approximately 3,000 ha of horticultural landscapes; approximately 150 decentralized water systems rehabilitating priority springs and catchments across 4 target districts; land-based livelihoods established for approximately 2,000 women and Indigenous Peoples households; and institutionalization of climate risk reduction in LSG planning across Kerala and Tamil Nadu through 1,200 BMCs and 13,200 trained members.

Cost-effectiveness

- **Efficiency:** approximately 74% of component cost directed to direct adaptation investment (Components 1, 2, and 3); enabling activities at approximately 7% (Component 4 including 4A), well within AF requirements.
- **Source-sink synergies:** Upstream restoration in Wayanad and the Nilgiris reduces the need for costly grey infrastructure downstream in Malappuram and Kozhikode, delivering corridor-wide hydrological benefits at a fraction of engineered alternatives. Decentralized water systems at USD 12,333 per system deliver equivalent outcomes at 60–80% lower cost than piped water supply schemes.
- **Complementary leverage:** Restoration investments embedded within CAMPA, MGNREGS, state forestry schemes, and the National Mission for Green India extend project reach and sustainability at no additional cost. MGNREGS co-financing at a 90:10 ratio applies to eligible water infrastructure structures. Blended finance mechanisms target an indicative USD 4–6 million in leveraged co-financing, a potential leverage ratio of 11–17 times the enabling investment
- **Institutional sustainability:** Post-project ownership confirmed for all components with named responsible institutions in Kerala and Tamil Nadu, including the Kerala State Biodiversity Board, State Training Centre for EbA, and State

Government departments holding digital adaptation platforms, ensuring sustained adaptation outcomes beyond the grant period.

K. Sustainability of the project/programme outcomes

- **Institutional sustainability and governance**

Climate resilience is embedded within statutory governance systems across Kerala and Tamil Nadu. Hazard maps, risk assessments, and their integration into Gram Panchayat Development Plans (GPDPs) and District Disaster Management Plans (DDMPs) ensure long-term mainstreaming. State EbA knowledge hubs, digital platforms, and cross-sectoral coordination mechanisms support continued implementation. A Corridor-Level Joint Coordination Committee (CLJCC), co-chaired by DoECC-Kerala and DECCF-Tamil Nadu, will coordinate transboundary implementation and convergence across sectors, transitioning to joint state ownership post-project. District Adaptation Coordination Committees (DACCs) will be integrated into District Disaster Management Authority (DDMA) structures, ensuring continuity within statutory mandates. Clear institutional roles across components, along with strengthened capacities of LSGs, state agencies, and community institutions, ensure that systems for climate risk management, ecosystem restoration, and adaptation planning continue beyond the project period.

- **Socio-economic sustainability and community ownership**

Community stewardship underpins the project's long-term sustainability. Component 2 links ecosystem restoration and human-wildlife coexistence with livelihood security through restoration of degraded hotspots, strengthening of existing nurseries (native and non-invasive commercial species), invasive species control, and establishment of community-based wildlife monitoring systems, with active participation of women and Indigenous Peoples. Livelihood enterprises - native plant nurseries, Lantana composting units, beekeeping, and NTFP value chains - are designed to be financially self-sustaining within the project period, giving households a continued stake in protecting restored ecosystems. Farmer Producer Organizations and community producer groups will sustain market linkages beyond project close. Through Component 3, climate resilience and EbA are embedded into LSG planning, budgeting, and coordination systems, institutionalizing inclusive decision-making and ensuring sustained community ownership beyond the project lifecycle.

- **Environmental sustainability through Nature-Based Solutions**

The project prioritizes NbS interventions that become increasingly self-sustaining as ecological restoration matures. Bioengineering measures - vetiver grass planting, bamboo fencing, contour trenches, gabion walls, and biofiltration structures - restore natural slope stability and hydrological regulation, creating ecological systems that strengthen over time without ongoing external maintenance. Rehabilitated springs, spring-sheds, and rainwater harvesting systems, governed by community water user groups and integrated into LSG water management plans, address seasonal water scarcity and strengthen hydrological resilience. Climate-informed land-use planning and Eco-DRR provisions, once embedded in GPDPs and DDMPs, become self-reinforcing through statutory annual planning cycles.

- **Financial sustainability and scalability**

The project establishes durable financial pathways through convergence of public finance, blended finance mechanisms, and risk transfer instruments. Standardized adaptation sub-project templates and strengthened LSG capacity enable continued financing of climate-resilient interventions through convergence with MGNREGS, CAMPA, state forestry schemes, and the National Rural Livelihood Mission beyond the project period. Parametric risk transfer instruments and disaster risk financing tools, formally handed over to NABARD, KIIFB, and TNIDB at project close, ensure rapid, shock-responsive recovery at community and local government levels. This co-financing is complementary and leveraged, it is not a prerequisite for the achievement of any project output or outcome. All outputs and their targets are fully deliverable within the Adaptation Fund grant of USD 15,000,000 alone. The leveraged finance serves to extend the reach and sustainability of interventions beyond the grant period, and to scale successful models across the wider NWC landscape, but its mobilization does not condition project success.

- **Exit strategy and long term continuity**

The project's exit strategy allocates the final 18 months to phased handover, capacity consolidation, and integration of interventions into government systems, with clear post-project institutional ownership. During months 43–48, institutional readiness assessments will be conducted, and climate data systems, EWS protocols, hazard maps, and monitoring frameworks will be transferred to DDMA and state agencies for integration into DDMPs and GPDPs. Community institutions will be formally registered under LSGs, which will assume responsibility for operation and maintenance of local systems, including water infrastructure and community-based monitoring mechanisms. During months 49–54, EbA knowledge hubs, digital platforms, and implementation tools will be transferred to DoECC-Kerala and DECCF-Tamil Nadu. Open-access toolkits, GPDP integration guidance, and training materials will be published, and the CLJCC will finalize post-project coordination and budget alignment. During months 55–60, a Terminal Evaluation will confirm completion of institutional

handover. DACCs will be integrated into DDMA structures, and financial instruments will be transferred to institutions such as NABARD, KIIIFB, and TNIDB. Final knowledge outputs will be disseminated for wider replication across the Western Ghats.

Post-project, continuity will be ensured through existing mandates: DDMA and LSGs will manage climate risk systems embedded in DDMPs and GDPDs; Forest Departments, supported by Biodiversity Management Committees and community stewardship groups, will sustain ecosystem restoration and wildlife corridors; state institutions will anchor EbA capacity building and digital platforms; and blended finance mechanisms will support ongoing adaptation investments. Climate-informed planning systems and participatory M&E will ensure sustained ecological, social, and institutional outcomes across the NWC.

L. Environmental and social impacts and risks identified as being relevant to the project/programme.

Checklist of environmental and social principles	No further assessment required for compliance	Potential impacts and risks: further assessment and management required for compliance
Compliance with the law	No	Low risk. Risk: The project spans Kerala and Tamil Nadu with overlapping forest, water, and disaster governance regulations. All project activities are designed in close consultation with MoEFCC, Kerala and Tamil Nadu state governments, forest departments, and local authorities to ensure legal compliance. Activities will be aligned with Forest Conservation Act, Wildlife Protection Act, Biological Diversity Act, and relevant state regulations. Evolving state or national regulations could require project adjustments during implementation. Mitigation: (i) Identify all permitting requirements for Nature-Based Solutions (NBS) and restoration activities; (ii) include compliance clauses in project agreements; (iii) monitor through the project risk monitoring framework. IA and EEs will coordinate with state authorities to reflect policy changes promptly.
Access and equity	No	Medium risk. Risk: Marginalized groups may face barriers in accessing project benefits. Mitigation: The project design explicitly integrates measures to ensure fair and equitable access, including inclusive stakeholder consultations, gender-responsive approaches, and Indigenous People Plan (IPP), with FPIC processes and a grievance mechanism to resolve any access issues. Special attention is given to women, youth, and marginalized indigenous groups to ensure their full participation in project benefits.
Marginalized and vulnerable groups	No	Medium risk. Risk: Vulnerable groups such as women, children, the elderly, persons with disabilities, informal workers, and indigenous groups (e.g., Kattunayaka and Paniya) may face barriers to participation due to poverty, caregiving responsibilities, or livelihood dependence. Mitigation: The project will implement targeted inclusion strategies, participatory planning, and Stakeholder Engagement Plan (SEP), Indigenous People Plan (IPP) and Gender Action Plan (GAP) to ensure equitable participation in restoration, governance, and livelihood interventions.
Human rights	No	Low risk. Risk: Activities could inadvertently violate human rights. Mitigation: Activities will follow the UN Declaration of Human Rights, ensuring non-discrimination in consultations, benefit distribution, and grievance handling. The ESMP will monitor adherence, and the grievance mechanism will handle any human rights-related complaints. The project actively promotes respect for human rights as an integral component of implementation.
Gender equity and women's empowerment	No	Low risk.

		Risk: Women in project areas are disproportionately affected by climate change, due to caregiving roles, dependency on public services, lower adaptive capacity, and participation in informal economies. Mitigation: The project addresses these risks by integrating gender-responsive measures in training, workshops, planning, and NBS-based livelihoods. The Gender Action Plan GAP will include enabling activities to promote women's empowerment, equitable participation, and access to decision-making, along with indicators and targets. Tailored interventions promote transformative gender outcomes while supporting climate-resilient livelihoods.
Core labour rights	No	Low risk. Risk: Use of migrant or informal workers may lead to unsafe or unfair labor practices. Mitigation: The PMU will ensure all project-supported employment complies with Indian labour laws, including the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGS) wage rates and standards for community workers. The PMU will provide guidance on occupational health and safety, human rights, and ILO standards, along with monitoring through the ESMP and inclusion of clauses in contracts with consultants and contractors.
Indigenous peoples	No	Medium risk. Risk: The project activities will take place in and around territories traditionally used by Indigenous People. The project is designed to benefit and include these communities, however activities involving land-use changes or access restrictions to restoration sites may have unintended impacts. For example ecosystem restoration activities may alter landscapes in ways that have cultural significance for Indigenous communities (e.g., shola-grassland restoration in areas used for traditional practices). Mitigation: Activities will follow FPIC protocols to safeguard customary rights and resource access. An Indigenous Peoples Plan (IPP) will be developed. Project activities will take place in and around territories traditionally used by Indigenous Peoples. FPIC will be applied throughout all stages of planning, implementation, and monitoring. Indigenous community consent will be obtained before any activities are implemented in or affecting their territories.
Involuntary resettlement	Yes Further analysis on land tenure implications will be conducted at project inception.	Medium risk. Risk: Project interventions could require temporary or permanent land use changes. Restoration site management and water user group governance may involve agreed access protocols for community lands. Mitigation: measures include careful site selection, consultation with affected communities, development of Resettlement and Livelihood Restoration Plans (if necessary), and consent procedures for works on private or public land. All restrictions on access will be negotiated transparently through FPIC, documented in community management agreements and subject to the GRM. The ESMP will guide mitigation and monitoring
Protection of natural habitats	No	Low risk. Risk: Interventions are planned in the Western Ghats, a UNESCO World Heritage Site and global biodiversity hotspot. The project targets degraded hotspots for restoration and does not propose interventions that would adversely impact legally protected areas. While all activities are designed to restore and enhance biodiversity, there is a minimal risk of unintended modification. The project specifically targets restoration of habitats for endemic and threatened species including Nilgiri Tahr, lion-tailed macaque, and Asian elephant. Invasive species removal (Lantana camara, Senna spectabilis) will improve habitat quality for endangered species Mitigation: Project activities are outside protected areas. NBS and restoration interventions will follow legal requirements and best practices, promoting sustainable land use, conservation, and ecosystem restoration. Strict site selection protocols and environmental screening will be applied to avoid impacts on high-conservation-value habitats. Activities will comply with India's Wildlife Protection Act and Forest Conservation Act. ESMP will be developed for the specific intervention sites.
Conservation of Biological Diversity	No	Low risk. Risk: NBS interventions will enhance biodiversity, restore habitat connectivity, and avoid invasive species. Restoration activities could inadvertently harm biodiversity.

		Mitigation: Species suitability assessments will be conducted prior to planting. All restoration will use only native species and ESMP monitoring will ensure biodiversity goals are met. Activities will comply with India's Wildlife Protection Act and Forest Conservation Act.
Climate change	Yes. climate risk assessments and modeling to guide resilient design and adaptive management of all project activities	Medium risk. Risk: Project outputs including ecosystem restoration, slope bioengineering, and spring-shed rehabilitation are themselves sensitive to climate change impacts such as intensifying rainfall, prolonged drought, and invasive species spread under warming conditions. Mitigation: Component 1 incorporates climate risk assessments and modeling to guide resilient design and adaptive management of all project activities.
Pollution prevention and resource efficiency	No	Low risk. Risk: Project activities could generate waste or inefficiencies. No significant release of pollutants is anticipated. Microbial composting of Lantana biomass using TNAU Biomineralizer and KAU microbial consortia produces organic soil amendment and does not involve chemical pollutants. Mitigation: Green biomass waste will be generated from systematic removal of invasive species (Lantana camara and Senna spectabilis) across approximately 8,000 ha of restoration sites. This is not hazardous waste. The project specifically addresses this through the Lantana composting enterprise, using TNAU Biomineralizer (Nilgiris) and KAU microbial consortia (Wayanad) to convert Lantana biomass into productive organic soil amendment, generating livelihood income for women and Indigenous community members. Moreover, activities such as rainwater harvesting and small-scale PV installations improve resource efficiency; NBS interventions enhance environmental quality.
Public health	No	Low risk. Risk: No pesticides or chemical fertilizers that could impact workers or community health are planned. The project promotes organic soil restoration through Lantana composting and TNAU/KAU microbial consortia. Mitigation: Agroforestry and climate-resilient crop diversification activities will follow organic and integrated pest management approaches. Interventions improve health outcomes through flood mitigation, water security, and ecosystem restoration. The project will comply with national health authority guidelines.
Physical and cultural heritage	No	Low risk. Risk: It's unlikely that works could affect cultural or physical heritage. Mitigation: Project sites are not located in areas of known physical or cultural heritage. Protection of cultural heritage will be considered during site selection. Any previously unidentified heritage encountered during minor works will be managed according to legal requirements. Activities are low-impact and primarily focus on ecosystem restoration.
Lands and soil conservation	No	Low risk. Risk: Soil erosion and degradation could occur. Mitigation: NBS and restoration interventions incorporate soil conservation measures, including erosion control, soil biodiversity protection, and productivity enhancement. No further assessment is required, as the project directly addresses this risk.

The project is determined to be Category C according to the Adaptation Fund Environmental and Social Policy F's ESP(corresponding to Moderate risk category of UNEP's UNEP Environmental and Social Sustainability Framework). The project's potential negative impacts are limited in scale and can be mitigated with standard mitigation measures developed in an Environmental and Social Management Plan (ESMP). The project will establish and ensure the availability of a grievance mechanism accessible to all stakeholders or anyone wishing to file a complaint related to project activities.

Information on the operation of this mechanism will be widely distributed among project participants, beneficiaries, organizations, and communities potentially affected by project activities. Emphasis will be placed on informing the existence of the grievance mechanism and on building local capacity to ensure that key implementing entities and stakeholders are informed of potential social and environmental impacts. Efforts will also focus on enhancing their capabilities to monitor and ensure compliance with social and environmental standards.

PART III: IMPLEMENTATION ARRANGEMENTS

Demonstrate how the project/programme aligns with the Results Framework of the Adaptation Fund

Project Framework	Project Indicator(s)	Adaptation Fund Expected Result	Adaptation Fund Indicator	Grant Amount (USD)
Objective: Reduce climate vulnerability and strengthen resilience of communities, ecosystems, and governance systems in the Nilgiri–Wayanad Corridor.	# of beneficiaries	People supported to strengthen their climate resilience	# of beneficiaries (core indicator 1)	
Outcome 1.1: Reduced loss of life, livelihoods, and assets from landslides, extreme rainfall, and flash floods through green-grey solutions and disaster preparedness.	• People with reduced risk to extreme weather events [Target: 10,000–15,000 households; 20 LEWS across 4 districts, by gender and IP status] • Number of hectares restored or sustainably managed to reduce exposure to landslides and flash floods [Target: ~8,000 ha across 4 districts]	Outcome 1: Reduced exposure to climate-related hazards and threats Outcome 5: Increased ecosystem resilience in response to climate change and variability-induced stress	Indicator 1: People using climate-related threat and hazard information Indicator 5 (Core Indicator 4): Ecosystems and natural resources brought under protection, restoration, or improved management in response to climate variability and change	Outcome 1: \$500,000 Outcome 5: \$6,000,000
Outcome 2.1: Women and IP households derive sustainable livelihoods from restoration investments	• Women and IP households with climate-resilient livelihoods [Target: ~2,000 households across 4 districts]	Outcome 6: Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas	Indicator 6A: People adopting improved and/or new climate-resilient livelihood practices	\$2,800,000
Outcome 3.1: Reduced household water insecurity through green-grey interventions to address intensifying dry spells, groundwater depletion, and seasonal hydrological disruption	• Households with improved reliable water access [Target: to be confirmed at FP stage, by gender and IP]	Outcome 4: Increased adaptive capacity within relevant development sector services and infrastructure assets	Indicator 4 (Core Indicator 3): Physical assets improved or constructed to withstand climate variability and change	\$1,850,000
Outcome 4.1: LSGs effectively plan, finance, and implement climate-resilient and biodiversity-positive actions through gender-responsive and IP-inclusive governance systems across Kerala and Tamil Nadu.	• LSGs and institutions with strengthened climate risk capacity [Target: 20+ LSGs; 1,200 BMCs; 13,200 members trained]	Outcome 2: Strengthened institutional capacity to reduce climate-induced socioeconomic and environmental losses	Indicator 2: Institutions with strengthened capacity to understand and better address climate risks and resilience	\$600,000
Outcome 4.2: Scaled and sustained adaptation investments enabled through mobilization of blended, risk-informed finance with explicit provisions for women-headed households and IP.	Amount (USD) of blended and risk-informed finance mobilized for climate adaptation investments, of which a defined percentage is allocated to women-	Outcome 2: Strengthened institutional capacity to reduce climate-induced socioeconomic and environmental losses	Indicator 2: Institutions with strengthened capacity to understand and better address climate risks and resilience	\$400,000

	headed households and Indigenous Peoples.			
Total outcome level grant amount				\$12,150,000

Project Outputs	Project Output Indicator(s)	Adaptation Fund Output	Adaptation Fund Output Indicator	Grant Amount (USD)
Output 1.1.1: 4 district-level composite vulnerability maps produced, integrating landslide and flood hazard data with social vulnerability indicators and sex-disaggregated data, embedded into at least 20 Gram Panchayat Development Plans and 4 District Disaster Management Plans across districts.	Hazard maps in local planning systems [Target: 4 maps in 20 GPDs and 4 DDMPs]	Output 1.1: Risk and vulnerability assessments conducted and updated	1.1: Risk and vulnerability assessments conducted or updated (by sector and scale)	\$200,000
Output 1.1.2: Approx. 500–700 vegetative bunds and contour trenches, 50 check dams, 50–70 gabion walls, and 200–300 recharge pits constructed to stabilize landslide-prone slopes in 2 montane districts (Nilgiris and Wayanad) and degraded catchments in acute hazard zones.	Landslide-prone slopes stabilized [Target: ~3,000 ha in Nilgiris and Wayanad]	Output 5.1: Vulnerable ecosystem services and natural resource assets strengthened in response to climate change, including variability	5.1: Ecosystems and natural resources targeted by activities to improve protection, restoration, and/or management	\$2,000,000
Output 1.1.3: 20 community-level localized early warning systems (LEWS) deployed across high-landslide-risk settlements in 4 target districts, covering an estimated 10,000–15,000 households.	- Number of women and IP members trained as EWS operators [Target: to be confirmed at FP stage, by gender and IP] - Number of community-level localized early warning systems (LEWS) deployed ; [Target: 20 LEWS in 4 districts, by gender and IP]	Output 1.2: Targeted population groups covered by warning and advisory services for climate-related hazards and threats	1.2A (Core Indicator 2): Early warning systems established or improved	\$300,000
Output 1.1.4: Approx. 8,000 ha of degraded forest, shola–grassland, and wildlife corridor habitats ecologically restored across 10–15 landscape sites in target districts, through native vegetation planting, shola–grassland restoration, and corridor and buffer zone management.	Number of hectares of degraded habitats restored or under assisted generation [Target: ~8,000 ha across 10–15 sites in 4 districts, by ecosystem type]	Output 5.1: Vulnerable ecosystem services and natural resource assets strengthened in response to climate change, including variability	5.1: Ecosystems and natural resources targeted by activities to improve protection, restoration, and/or management	\$4,000,000
Output 2.1.1: At least 4 nurseries (including native and non-invasive commercial species) strengthened and operational, supplying planting stock for restoration activities and managed by IP and women as community enterprises integrating Indigenous knowledge.	Nurseries (including native and non-invasive commercial species) operational as community enterprises [Target: at least 4 nurseries, one per district, managed by IP and women]	Output 6.1: Targeted individual and community livelihood strategies strengthened in relation to climate change impacts, including variability	6.1: People receiving targeted support for new and/or improved livelihoods to manage climate risk	\$400,000
Output 2.1.2: Approx. 4,000 ha cleared of invasive species converted into organic compost via TNAU Biomineralizer (Tamil Nadu) and KAU microbial consortia (Kerala), channeled into organic farming and soil restoration across approx. 3,000 ha of horticultural landscapes in the 4 target districts.	- Area cleared of invasive species and converted to organic compost [Target: ~4,000 ha across 4 districts, by state] - Horticultural landscapes receiving soil restoration [Target: ~3,000 ha across 4 districts]	Output 6.1: Targeted individual and community livelihood strategies strengthened in relation to climate change impacts, including variability	6.1: People receiving targeted support for new and/or improved livelihoods to manage climate risk	\$1,400,000

Output 2.1.3: Land-based livelihood training and equipment support for approx. 2,000 women and Indigenous Peoples households, through Lantana composting, nurseries, NTFP value chains, agroforestry, and restoration-linked enterprises across 4 target districts.	• Women and IP households supported with land-based livelihood training and equipment [Target: ~2,000 households, by gender and IP community]	Output 6.1: Targeted individual and community livelihood strategies strengthened in relation to climate change impacts, including variability	6.1: People receiving targeted support for new and/or improved livelihoods to manage climate risk	\$1,000,000
Output 3.1.1: Approximately 150 decentralized water systems rehabilitated or constructed across 4 target districts, comprising approximately 40 priority springs rehabilitated, 50 check dams, 30 percolation pits, and 30 rainwater harvesting systems.	• Decentralized water systems rehabilitated [Target: ~150 systems: 40 springs, 50 check dams, 30 percolation pits, 30 rainwater harvesting, across 4 districts, by state] • Community water user groups established with gender-balanced governance and IP representation [Target: at least 4, one per district]	Output 4.1: Vulnerable development sector services and infrastructure assets strengthened in response to climate change impacts, including variability	4.1: Development sector services strengthened to respond to climate variability and change	\$1,850,000
Output 4.1.1: 1 State Training Centre for EbA established in Kerala; 1,200 Biodiversity Management Committees (13,200 members) trained in climate-resilient EbA planning across Kerala and Tamil Nadu; and EbA integration toolkits disseminated to at least 20 LSGs	• BMC members trained in EbA planning [Target: 13,200 across 1,200 BMCs, by gender and IP] • State Training Centres for EbA established [Target: 1 in Kerala]	Output 2.1: Strengthened capacity of institutions to understand and better address climate risks	2.1: Institutions supported to strengthen capacity to understand and address climate risks and resilience	\$400,000
Output 4.1.2: At least 3 cross-district and cross-state peer learning workshops conducted; at least 20 LSGs integrating EbA into annual budgets and development plans, supported by operational digital adaptation platforms.	• Cross-state peer learning workshops [Target: at least 3] • LSGs integrating EbA into GPDPs, budgets, and plans [Target: at least 20 LSGs, by state]	Output 2.1: Strengthened capacity of institutions to understand and better address climate risks	2.1: Institutions supported to strengthen capacity to understand and address climate risks and resilience	\$200,000
Output 4.2.1: At least 2 blended finance mechanisms designed and piloted, leveraging NAFCC, GEF, GCF, state climate funds, CSR, and multilateral banks, and building on existing local biodiversity funds delivering small grants to approx. 500 farmers, IP community members, and women-led enterprises across 4 districts	• Blended finance and risk financing mechanisms piloted [Target: at least 2 blended finance including operationalization of existing Local biodiversity fund beneficiaries Targeting: ~500 farmers, IP members, and women-led enterprises across 4 districts]	Output 2.1: Strengthened capacity of institutions to understand and better address climate risks	2.1: Institutions supported to strengthen capacity to understand and address climate risks and resilience	\$200,000
Output 4.2.2: Parametric climate risk financing and crop/livestock insurance mechanisms designed and piloted for at least 500 women-headed and IP households.	• Women-headed and IP households covered by parametric insurance [Target: at least 500, by gender and IP]	Output 2.1: Strengthened capacity of institutions to understand and better address climate risks	2.1: Institutions supported to strengthen capacity to understand and address climate risks and resilience	\$200,000
Total output level grant amount				\$12,150,000

PART IV: ENDORSEMENT BY GOVERNMENTS AND CERTIFICATION BY THE IMPLEMENTING ENTITY

A. Record of endorsement on behalf of the government²⁰

<i>Rajasree Ray</i> <i>Economic Adviser</i> <i>Ministry of Environment, Forest and Climate Change, India</i>	Date: July, 20 th . 2026
--	-------------------------------------

B. Implementing Entity certification

I certify that this proposal has been prepared in accordance with guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans and subject to the approval by the Adaptation Fund Board, <u>commit to implementing the project/programme in compliance with the Environmental and Social Policy of the Adaptation Fund</u> and on the understanding that the Implementing Entity will be fully (legally and financially) responsible for the implementation of this project/programme.	
<i>Mirey Atallah</i> <i>Chief, Adaptation & Resilience Branch</i> <i>Climate Change Division, UNEP</i>	
Date: August 10, 2026	Tel. and email: mirey.atallah@un.org
Project Contact Person: Jessica Troni; Paz Rey	
Tel. And Email: Jessica.troni@un.org ; paz.lopezrey@un.org	

Annex 1 - References

- Anjitha, A.C. et al. (2024) 'Battling climatic shifts: Vulnerability of coffee-based farm households in Wayanad, Kerala', Indian Journal of Agricultural Economics.
- Centre for Climate Change and Disaster Management, Department of Civil Engineering, Anna University. (2024a). *Climate profile and projections of Tamil Nadu (Climate Modelling)*. Chennai, India.
- Centre for Climate Change and Disaster Management, Department of Civil Engineering, Anna University. (2024b). *Climate risk assessments and adaptation plan for Tamil Nadu (Under Climate Studio)*. Chennai, India.
- Centre for Climate Change and Disaster Management, Department of Civil Engineering, Anna University. (2024c). *Climate risk assessment and adaptation plan for Tamil Nadu – Forest habitat suitability (Under Climate Studio)*. Chennai, India.
- Census of India. (2011). *Office of the Registrar General and Census Commissioner, India*. Government of India.
- Environment Department, Government of Kerala. (2025). *Advancing adaptation and development action through source–sink synergies for climate resilience in the villages of NBR–Chaliyar River Basin (Concept note proposal for UNEP Adaptation Fund)*. Government of Kerala.
- Government of Kerala, State Planning Board. (2025). *Economic review 2024 (Vol. 1)*. Thiruvananthapuram, India: Government of Kerala.
- Intergovernmental Panel on Climate Change (IPCC). (2014). *Climate change 2014: Synthesis report*. Geneva, Switzerland: IPCC.
- Intergovernmental Panel on Climate Change (IPCC). (2021). *Climate change 2021: The physical science basis (AR6 Working Group I)*. Cambridge University Press.
- Kumara, H, Singh, M and Irfan-Ullah, Mohammed, Kumar, (2013). Status, Distribution, and Conservation of Slender Lorises in India. 10.1007/978-1-4614-4511-1_38
- Kumar, S. N., Aggarwal, P. K., Rani, S., Jain, S., Saxena, R., and Chauhan, N. (2011). Impact of climate change on crop productivity in Western Ghats, coastal and northeastern regions of India. *Current Science*, 101, 332–341.
- Kerala State Action Plan on Climate Change 2023–2030. (2022). Department of Environment and Climate Change, Government of Kerala.
- Ministry of Environment and Forests. (2013). *Report of the High Level Working Group on Western Ghats (Part I)*. Government of India. https://moef.gov.in/uploads/2021/08/1-HLWG-Report-Part-1_0.pdf

⁶. Each Party shall designate and communicate to the secretariat the authority that will endorse on behalf of the national government the projects and programmes proposed by the implementing entities.



राजश्री रे
RAJASREE RAY



आर्थिक सलाहकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
भारत सरकार
ECONOMIC ADVISER
MINISTRY OF ENVIRONMENT, FOREST
AND CLIMATE CHANGE
GOVERNMENT OF INDIA

D.O. 13008/30/2025 - CC

20th July, 2026

To,

The Adaptation Fund Board
C/o Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Subject: Endorsement for "Enhancing community and ecosystem climate resilience in the Nilgiri-Wayanad Corridor".

In my capacity as Designated Authority for the Adaptation Fund in India, I confirm that the above national grant proposal is in accordance with the government's national priorities in implementing adaptation activities to reduce adverse impacts of, and risks, posed by climate change in India.

Accordingly, I am pleased to endorse the above grant proposal with support from the Adaptation Fund. If approved, the project will be implemented by the United Nations Environment Programme (UNEP) and executed by the Department of Environment and Climate Change in the States of Tamil Nadu and Kerala.

Yours sincerely,

(Rajasree Ray)



Revised PFG Submission Form¹ (additions in red)

Project Formulation Grant (PFG)

Submission Date: 17 July 2026

Adaptation Fund Project ID: N/A

Country/ies: India

Title of Project/Programme:

Enhancing community and ecosystem climate resilience in the Nilgiri–Wayanad Corridor

Type of IE (NIE/RIE/MIE): MIE

Implementing Entity:

United Nations Environment Programme (UNEP)

Executing Entity/ies: UNEP (100% of grant)

A. Project Preparation Timeframe

Start date of PFG	15 November 2026
Completion date of PFG	15 November 2027

B. Proposed Project Preparation Activities (\$)

List of Proposed Project Preparation Activities	Output of the PFG Activities	US\$ Amount	Budget note²
1.Full proposal formulation including annexes to full proposal		103,250	Consultancy firm cost based on market rates
2.Stakeholder consultation processes	1	26,000	4-5 district-level consultation workshops and community-level consultations and FPIC processes @ 20,000 and 2 state-level consultation validation workshops @ 6,000USD

¹ As presented in AFB/PPRC.33/40 Annex 1.

² The proposal should include a detailed budget with budget notes indicating the break- down of costs at the activity level. It should also include a budget on the Implementing Entity management fee use.

3. Capacity assessments and risk management plan		8,000	2 HACT assessments on executing entities @ 4,000 USD
Total PFG activities		137,250	
IE management fee		12,750	
Total PFG grant request		150,000	

Please describe below each of the PFG activities and provide justifications for their need and for the amount of funding required:

The proposal will be prepared based on the endorsed concept note. The proposal will be prepared with the involvement and validation of national and local stakeholders. Field-level consultations and FPIC processes will take place among the communities to be supported. The information gathered will be location-specific and quantitative as far as possible. Data and information should be recent and referenced. The proposal should incorporate the following key aspects:

1. Full proposal development and annexes

The information gathered during the above in-depth and implementation-oriented consultation process will be used to develop the full proposal for the Single Country Regular Project including:

- Detailed Results Framework for the project, including SMART indicators and targets aligned with the Adaptation Results Framework.
- Implementation workplan and milestones.
- Costed M&E and knowledge management plan.
- Stakeholder Engagement Plan
- Gender assessment and Costed Gender Action Plan
- Costed Environmental and Social Management Framework, Indigenous People Plan.
- Detailed budget and budget notes, including quantification of stakeholders' in-kind contributions
- Sustainability and exit strategy

Stakeholder Engagement Plan

The plan will define the roles and responsibilities of each government institution, implementation partners and stakeholders at the national, regional, district and community level in the project implementation and monitoring at different levels. The plan will include measures to mitigate financial, reputational, security and other risks.

Gender Action Plan

The existing gender analysis will be further developed to identify gender-differentiated climate impacts, risks, and opportunities to address gender gaps and promote women's empowerment in the specific context of the target areas. A costed Gender Action Plan for the project will be developed identifying gender-responsive measures to address differences, identified impacts, risks, and opportunities. The plan will include indicators and sex-disaggregated targets in the project results framework.

Environmental and Social Management Framework (ESMF) and Indigenous Peoples Plan (IPP)

Environmental and social safeguards (ESS) screening was conducted during concept note preparation using UNEP's Safeguards Risk Identification Form (SRIF), which categorized the project as Moderate Risk. During project formulation, a renewed safeguards screening and assessment will be undertaken for the fully designed project components. Any component that could potentially be classified as High Risk will be redesigned to ensure that the overall risk category of all project components remains Moderate Risk.

An Environmental and Social Management Framework (ESMF) will be developed to identify the main environmental and social risks associated with the project and define appropriate mitigation measures, drawing on stakeholder consultations and lessons learned from similar interventions. The ESMF will provide the framework for managing safeguards risks associated with project interventions in the target areas. During the inception phase, a more detailed Environmental and Social Management Plan (ESMP) will be prepared, taking into account the specific characteristics of the selected sites for restoration, water resource management, and livelihood investments. The ESMF will be developed in accordance with the Adaptation Fund Environmental and Social Policy and UNEP's Environmental and Social Sustainability Framework (ESSF).

An integral component of the ESMF will be the preparation of an Indigenous Peoples Plan (IPP), including the application of Free, Prior and Informed Consent (FPIC) processes, as appropriate, during project formulation, implementation, and monitoring. The IPP will aim to ensure meaningful, inclusive and culturally appropriate engagement processes throughout programme implementation.

2. Stakeholder consultation

A round of stakeholder consultations at the state level and in the prioritized districts is required to develop participatory project design and implementation processes that are inclusive and effective across the different levels of intervention proposed by the project (national, state, district, community and household level). The consultation process will inform the:

- Identification of priority target areas within each district and validation of criteria for the selection of appropriate sites for further assessment during project implementation
- Identification of implementing partner organizations and capacity assessment, including identification of measures to manage financial, reputational and security risks in the districts of intervention.
- Identification of the roles and responsibilities of each government institution and stakeholders in project implementation and monitoring at different levels.
- Identification of result framework SMART indicators and targets aligned with the Adaptation Results Framework.
- Identification of costed activities necessary to attain the planned outputs and outcomes and a detailed budget.
- Gender Action Plan, Environmental and Social Management Framework, Indigenous Peoples Plan and the Stakeholder Engagement Plan.
- Sustainability and exit strategy

3. Capacity assessment and risk management plan

Micro HACT (Harmonized Approach to Cash Transfers) assessments will be carried out on the two proposed executing entities, the Department of Environment and Climate Change of Tamil Nadu state and the Department of Environment and Climate Change of Kerala state to confirm the execution arrangements of the project and elaborate the risk management plan.

C. Implementing Entity

This request has been prepared in accordance with the Adaptation Fund Board's procedures and meets the Adaptation Fund's criteria for project identification and formulation

Implementing Entity Coordinator, IE Name	Signature	Date (Month, day, year)	Project Contact Person	Telephone	Email Address
UNEP Mirey Atallah		17 /07/2026	Jessica Troni	254795751062	Jessica.troni@un.org

- Parthasarathy, D., Nair, A., and Thomas, R. (2021). Compounding hazards: Floods, landslides, and social vulnerability in Kerala, India. *Climate and Disaster Policy Review*.
- Paul, S., Ghosh, S., Rajendran, K., and Murtugudde, R. (2018). Moisture supply from the Western Ghats forests to water-deficit east coast of India. *Geophysical Research Letters*, 45(9), 4337–4344.
- Reddy, C. S., Jha, C. S., and Dadhwal, V. K. (2016). Assessment and monitoring of long-term forest cover changes (1920–2013) in the Western Ghats biodiversity hotspot. *Journal of Earth System Science*, 125(1), 103–114.
- Sundaran, N. K., Radhakrishnan, A., Ravindran, D., Bonny, B. P., and Nandini, N. V. (2024). *Climate change and farmer livelihoods in Wayanad, India: A livelihood vulnerability index assessment*.
- Tamil Nadu State Action Plan on Climate Change (TNSAPCC). (2015). Endorsed by the Ministry of Environment, Forests and Climate Change, Government of India.
- United Nations Environment Programme (UNEP). (2025a). *Building climate resilient villages: Village adaptation and development action initiative – Adaptation Fund pre-concept note*.
- United Nations Environment Programme (UNEP). (n.d.). *Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents*.
- Vidya, S., and Murthy, I. K. (2022). *District-level changes in climate: Historical climate and climate change projections for the southern states of India*. Centre for Study of Science, Technology and Policy.
- Adil, L., Eckstein, D., Künzel, V., & Schäfer, L. (2025). *Climate Risk Index 2026 – Who suffers most from extreme weather events?* Germanwatch e.V. <https://www.germanwatch.org/sites/default/files/2025-11/CRI%2026%20full%20report.pdf>
- Ministry of Environment, Forest and Climate Change. (2024). *Annual report 2024–25*. Government of India. https://moef.gov.in/uploads/pdf-uploads/English_Annual_Report_2024-25.pdf
- UNEP-WCMC. (2023). *Western Ghats – World Heritage datasheet*. UNEP-WCMC. <https://world-heritage-datasheets.unep-wcmc.org/datasheet/output/site/western-ghats/>
- Kodandapani, N., & Parks, S. A. (2019). *Effects of drought on wildfires in forest landscapes of the Western Ghats, India*. *International Journal of Wildland Fire*
- Adil, L., Eckstein, D., Künzel, V., & Schäfer, L. (2025). *Climate Risk Index 2026: Who suffers most from extreme weather events*
- Kerala State Disaster Management Authority. (2025). *Flash Floods and Landslides 2024–2025 (FPS report)*. <https://sdma.kerala.gov.in/wp-content/uploads/2026/03/FPS2025.pdf>



Stakeholder Consultations report

(27th January – 3rd February 2026)

Adaptation Fund single country concept “Enhancing community and ecosystem climate resilience in the Nilgiri-Wayanad Corridor”

About the project

The project focuses on the Nilgiri–Wayanad–Chaliyar Corridor (NCC), a transboundary landscape in the southern Western Ghats spanning Kerala and Tamil Nadu. This ecologically critical corridor functions as a source sink system, linking high-altitude forested headwaters in the Nilgiris and Wayanad with agrarian midstream valleys. The NCC is undergoing a severe environmental crisis driven by long-term forest degradation and accelerating climate change. Over the past century, the region has experienced a 35.3% decline in forest cover¹. This has reduced the landscape's natural capacity to absorb rainfall, recharge groundwater, and regulate river flows. Climate change has further intensified these vulnerabilities through rising temperatures, increased heatwave frequency, extreme rainfall events causing landslides, and prolonged dry periods leading to water scarcity.

The Adaptation Fund project aims to restore ecosystem integrity and strengthen climate resilience through integrated landscape-level interventions. Social inclusion is a central focus of the project. It prioritizes Particularly Vulnerable Tribal Groups addresses gender inequities by aiming to ensure women's and other vulnerable groups participation in governance and capacity-building processes, and supports smallholder farmers with limited incomes through technical training and climate advisory services. The project aligns closely with India's National Action Plan on Climate Change, the Green India Mission, and the National Mission for Sustainable Agriculture, while operationalizing Kerala's SAPCC 2.0 and the Tamil Nadu Climate Change Mission. It also contributes directly to the UN Sustainable Development Goals, particularly SDGs 2, 13, and 15.

Background

The primary objective of the stakeholder consultation is to ensure that the proposal design is grounded in the knowledge, priorities, and lived experiences of the landscape stakeholders, while also meeting the Adaptation Fund's requirements for meaningful, culturally appropriate engagement. Specifically, the consultations aim to identify and prioritize potential project sites, gather insights into the ecological, social, and economic conditions of the landscape, and document stakeholder perspectives on risks, vulnerabilities, and adaptation needs.

A key objective is to communicate the project's goals, scope, and proposed interventions to regional agencies, local communities and other groups, to increase understanding, ownership, and engagement. Consultations will collect feedback on livelihoods, land use, hydrological stress, forest fragmentation, and human-wildlife conflict, ensuring that these perspectives inform the design of interventions. The consultation will also ensure inclusion of marginalized and vulnerable groups, particularly women and Particularly Vulnerable Tribal Groups. The process will also inform them regarding the Free, Prior, and Informed Consent (FPIC) principles², gender-sensitive approaches, and culturally appropriate facilitation, ensuring that the voices of those most affected by environmental and climate risks are incorporated into proposal design. Finally, the consultation process will provide baseline information for future monitoring and evaluation, including qualitative insights into community resilience, adaptation strategies, and ecosystem restoration priorities.

Stakeholders for the Nilgiri–Wayanad–Chaliyar Corridor (NCC) have been identified based on preliminary identification and a desk review of relevant studies. The selection was guided by the following criteria:

- Institutional roles in climate adaptation planning, policy formulation, and on-ground implementation, as well as their influence over land, forest, and water resources.
- Degree of exposure and vulnerability to climate-induced hazards, including landslides, hydrological stress, and livelihood insecurity.

Considering areas categorized along the corridor, the Upper Montane Headwaters (Wayanad and Nilgiris) are highly vulnerable to landslides, extreme rainfall, thermal stress, and forest fragmentation. The Midstream Regulating Zones (Malappuram, Coimbatore, and Erode) face wet-drought dynamics, thermal stress, and water scarcity.

Stakeholder Consultation Plan

Date	Day	Location	Activity
Jan 22	Thu	Virtual	State-level Preparation Meeting: Tamil Nadu
Jan 23	Fri	Virtual	State-level Stakeholder Meeting: Kerala
Jan 27	Tue	Chennai	Joint State and District-level Workshop (participants from Nilgiris and Coimbatore traveling to Chennai)
Jan 28	Wed	Transit	To Kozhikode
Jan 29	Thu	Wayanad	Travel to Kalpetta; Field visit and meeting with Indigenous/vulnerable groups (Afternoon)
Jan 30	Fri	Wayanad	District-level Stakeholder (Kerala Districts) in Kalpetta
Jan 31	Sat	Gudlur	Community level consultations at Gudalur
Feb 1	Sun	Ooty	Community level consultations at Ooty
Feb 2	Mon	Coimbatore	Community level consultations in Coimbatore
Feb 3	Tue	Transit	Travel from Coimbatore to Delhi

Consultation 1- State-level Stakeholder Meeting- Kerala

Date: 23 January 2026

Participants: 41

- The consultation aimed to strengthen the proposed Adaptation Fund project by incorporating inputs from state departments, technical agencies, and sectoral stakeholders to develop a robust and relevant project design.
- State authorities highlighted the Western Ghats corridor as highly vulnerable due to its geographic fragility, ecological sensitivity, and socio-economic challenges, including the presence of ethnic and vulnerable communities.
- The strategic importance of the corridor was emphasised, particularly its transboundary nature with Tamil Nadu and the Chaliyar River Basin's elevation gradient connecting upstream, midstream, and downstream regions.
- Significant overlap with Ecologically Sensitive Areas and accelerating biodiversity loss were noted as compounding climate risks.
- The Kerala State Biodiversity Board expressed strong interest in playing a leading role, with a focus on ecosystem- and biodiversity-based adaptation planning.
- UNEP presented the Adaptation Fund context, initial findings, and a baseline vulnerability assessment, outlining key climate risks, problem statements, and potential adaptation pathways.
- Stakeholders recommended aligning the project with the Kunming–Montreal Global Biodiversity Framework and India's National Biodiversity Strategy and Action Plan.
- There was broad consensus on limiting the geographic scope for feasibility, with Wayanad identified as essential and Malappuram or Kozhikode suggested as a second focus district.
- Priority interventions highlighted included ecosystem restoration, invasive species management, agro-biodiversity conservation, protection of sacred groves, recognition of other effective area-based conservation measures, and strengthening custodian farmer models linked to livelihood security.
- The State Disaster Management Authority highlighted that while early warning systems and evacuation planning have improved, environmental restoration remains a critical gap, particularly in relation to invasive species, forest degradation, water scarcity, and human–wildlife conflict.
- Nature-based solutions, restoration of natural water sources, and capacity building for local governments to better utilise existing disaster and mitigation funds were strongly recommended.
- Sectoral departments highlighted climate impacts across agriculture, coffee, livestock, spices, irrigation, and water resources, with water stress, landslides, soil erosion, and declining groundwater emerging as cross-cutting concerns.

- Stakeholders noted fragmentation across departments and recommended stocktaking of ongoing initiatives, improved convergence, and stronger training-of-trainers models for effective ground-level implementation.
- Additional inputs stressed the importance of spring rejuvenation, climate-resilient waste management systems, One Health approaches linking ecosystem and human health, and embedding social innovation and gender equity in project design.
- UNEP clarified next steps, including finalisation and submission of the concept note, development of the full proposal thereafter, and expected project implementation from 2027 onwards.

Consultation 2- State-level Stakeholder Meeting- Tamil Nadu

Date: 27 January 2026

Participants: Over 100

- State stakeholders highlighted that most climate initiatives in Tamil Nadu have historically focused on coastal ecosystems, and this consultation marked a first major shift towards the Western Ghats, described as the backbone of climate action due to its role in regulating water systems, biodiversity, and livelihoods.
- The scale and ambition of ecosystem restoration efforts in the Western Ghats were emphasised, particularly the ongoing removal of invasive species across approximately 34,000 hectares of forest land. The Mudumalai restoration unit was cited as a successful, field-tested model that demonstrates the feasibility of landscape-scale restoration.
- Across the Nilgiris, Coimbatore, and Gudalur, stakeholders identified escalating climate risks including landslides, extreme rainfall and heat, chronic water stress, severe soil erosion, forest fires, invasive species spread, and intensifying human–wildlife conflict, all of which are compounding ecological and livelihood vulnerabilities.
- The Nilgiris district was highlighted as especially fragile and landslide-prone, with critical importance for catchment security, water flow regulation, ecosystem services, and downstream water availability. The absence of a weather station was flagged as a significant gap, limiting climate risk monitoring and early warning capabilities.
- Forest Department representatives reported increasing climatic variability, with sharp inter-annual differences in monsoon performance over recent years resulting in alternating water scarcity and flooding. Soil erosion of approximately 40 tonnes per hectare per year is contributing to dam siltation, reduced storage capacity, compromised hydrology, and increased disaster risk, alongside rising forest fire incidence and tourism-related waste management pressures.
- Stakeholders emphasised that well-designed adaptation interventions in the Western Ghats can deliver long-term livelihood stability, ecosystem resilience, and water security, with mitigation benefits emerging as co-benefits rather than primary objectives.
- Strong consensus emerged around ecosystem- and biodiversity-based adaptation approaches, including shola forest and grassland restoration, invasive species management, habitat connectivity to support wildlife movement, and integration of circular economy principles into restoration and livelihood activities.
- Community representatives highlighted growing crop losses due to wildlife and birds, the disappearance of traditional and medicinal plant species as a result of invasive species, repeated monsoon failures over the past decade, severe soil erosion, and increasing human–wildlife conflict, all of which are directly affecting food security and livelihoods.

Summary note:

A technical consultation was convened by the Government of Tamil Nadu in collaboration with UNEP and partner institutions to inform preparation of a large-scale Adaptation Fund proposal focused on the Western Ghats landscape across Tamil Nadu and Kerala. The discussion brought together state departments, the Tamil Nadu Green Climate Company, forest officials, research organizations, civil society groups, and community representatives, including indigenous stakeholders. The objective was to ground the proposal in current climate risk evidence, district-level planning work, and ongoing field initiatives.

Participants noted that current climate projections for the Nilgiris and Coimbatore districts show a marked increase in monsoon rainfall days, heavy rainfall events, summer temperatures, and warm days, including higher probability of cloudburst-type events. These trends point to rising exposure of ecosystems, infrastructure, and livelihoods to climate shocks. While mitigation efforts remain necessary to reduce long-term emissions, there was broad agreement that adaptation measures are urgently required to safeguard development gains and reduce near- to medium-term risk. Adaptation was positioned as a practical complement to mitigation and aligned with the state's longer-term net zero pathway.

District-level climate assessments indicate differentiated risk profiles. In Nilgiris, the dominant risks include landslides, slope instability, catchment degradation, ecosystem sensitivity, water insecurity, and livelihood vulnerability in hill and forest-dependent communities. In Coimbatore, priority risks include urban flooding, extreme rainfall, heat stress, water stress, and industrial vulnerability, alongside pressures from rapid urban expansion. These risks persist even under mitigation scenarios due to underlying ecological and settlement patterns.

The consultation identified several priority investment areas for adaptation programming:

Landslide and Slope Risk Management (Nilgiris): Risk-informed land-use planning, micro-zonation of high-risk settlements, slope-sensitive development controls, and structural and bio-engineering stabilization measures, particularly along critical transport corridors. Expected outcomes include reduced loss of life and assets, improved infrastructure reliability, and lower disaster response costs.

Ecosystem Restoration and Nature-Based Measures: Restoration of Shola forests and montane grasslands through invasive species removal and assisted natural regeneration, guided by existing ecological mapping. These measures are expected to strengthen slope stability, improve hydrological function, and restore biodiversity, while generating local employment.

Water and Catchment Security: Spring-shed and watershed restoration, recharge enhancement, and rainwater harvesting to improve infiltration and moderate runoff under high-intensity rainfall. Catchment treatment was recognized as central to both disaster risk reduction and water security.

Climate-Resilient Tourism and Local Livelihoods (Nilgiris): Climate-sensitive destination planning, low-impact tourism infrastructure, and improved waste and wastewater systems,

combined with community-led eco-livelihood models to maintain income while reducing ecological pressure.

Disaster Preparedness and Early Warning: Strengthening localized early warning systems for landslides and extreme rainfall, and targeted implementation of existing disaster management plans, with attention to last-mile connectivity and service continuity in high-risk zones.

Urban and Peri-Urban Resilience (Coimbatore): Measures to address urban heat and flood risk through blue-green infrastructure, wetland and river corridor restoration, and drainage improvements, aligned with the Coimbatore master plan and supported by hotspot-based prioritization.

Forest Landscape Management and Human-Wildlife Interface: Corridor and buffer zone management, forest restoration, and catchment treatment in conflict-prone areas to improve ecosystem integrity, carbon sequestration, and livelihood outcomes for forest-fringe communities.

Climate-Resilient Agriculture: Promotion of climate-smart agriculture in peri-urban and rural clusters, including micro-irrigation, soil-moisture-based scheduling, water storage, and advisory support services to stabilize yields under increasing climate variability.

Decentralized Climate Governance: Establishment of local climate action cells at city and ward levels to support risk tracking, periodic plan updates, and community engagement, recognizing that climate risk profiles are evolving and require iterative planning.

The consultation supported development of a landscape-based adaptation programme for the Western Ghats that integrates ecosystem restoration, risk reduction, resilient infrastructure, and livelihood security. Emphasis was placed on practical, field-tested interventions, strong community participation, and alignment with existing state climate and development initiatives.

Consultation 3- District-level and Community-level Stakeholder Meeting- Kalpetta, Wayanad

Focus group discussion 1- District Officials

Participants: 77

Context and Historical Land-Use Change- District officials noted that Wayanad was historically known as “*Vayal Nadu*”, meaning land of paddy fields. Over time, this has shifted to “*Wayanad*”, reflecting a transition away from subsistence paddy cultivation towards plantation and cash-crop agriculture. This land-use change has significantly altered water availability, soil conditions, and livelihood systems.

Groundwater levels have declined, and irrigation water availability has reduced substantially, affecting both agriculture and domestic water use. Paddy cultivation has decreased, while cash crops such as coffee, tea, turmeric, and cardamom have become dominant.

Livelihood Risks and Agricultural Stress- Officials highlighted that livelihoods in Wayanad are predominantly agriculture-based, making them highly vulnerable to climate variability and market shocks. Declining productivity and increasing costs are directly affecting income generation.

Land acquisition policies in the past provided households with small land parcels; however, officials noted that once land is lost due to distress sales or degradation, it is rarely recovered, leading to long-term livelihood insecurity.

Pest attacks, particularly on cardamom, were identified as a serious concern. Pest infestations are affecting export-quality produce, prompting farmers to use increasingly severe levels of pesticides, further escalating costs and environmental risks.

Water and Drinking Water Challenges- Potable (drinking) water was identified as a major challenge across the district. Reduced groundwater levels and limited surface water availability have increased dependence on external water supply systems, while local water security continues to weaken.

Health and Social Concerns- Health risks associated with agriculture were highlighted, particularly the lack of protective measures during pesticide application. Exposure to agro-chemicals poses risks to farmers and farm workers, with limited awareness or access to protective equipment.

Officials also raised concerns about high levels of alcoholism in the district, which was linked to livelihood stress, income instability, and broader social vulnerability.

Access to forest resources has become increasingly restricted, and common lands have reduced over time. This has limited traditional livelihood options and increased dependence on fragile agricultural income.

Community Composition and Vulnerability- District officials highlighted the diversity of communities in Wayanad, including:

- **Paniya** communities, historically subjected to bonded labour
- **Kattunayaka**, forest-dwelling Particularly Vulnerable Tribal Groups
- **Kuruma**, traditionally agrarian communities and artisans
- **Cholanaika**, with strong forest-based livelihoods

These communities were identified as facing disproportionate vulnerability due to restricted forest access, declining commons, health risks, and limited livelihood diversification.

Landslides and Disaster Risk Context

Wayanad has a long history of landslide risk linked to monsoon rainfall and fragile hill ecosystems. Landslides were first formally reported in the district in 1980, with subsequent medium-scale events recorded in 2020. On 30 July 2024, Wayanad experienced one of the most severe disaster events in its history, when a series of devastating landslides, triggered by record monsoon rainfall, struck the Meppadi panchayat in Vythiri taluk.

The most affected areas included Punjirimattom, Mundakkai, and Chooralmala, along with surrounding villages. Intense and prolonged rainfall caused the Iruvanipuzha River to swell rapidly, generating an estimated 15-metre-high debris flow that swept through settlements and agricultural land. The scale and speed of the event left little time for evacuation.

The disaster resulted in exceptionally high human losses. Fatality estimates range from approximately 250 to over 400 people, making it one of the deadliest landslide events in Kerala. Hundreds more were injured, and many were reported missing in the immediate aftermath. Physical damage was extensive, with more than 550 houses completely destroyed, alongside roads, footbridges, irrigation channels, and community infrastructure.

Livelihood impacts have been severe and are likely to be long-lasting. The affected catchment areas are predominantly agrarian, with livelihoods centered on small-scale cultivation of rice and cardamom, supplemented by non-timber forest products (NTFPs) such as wild berries and honey. Landholdings are highly fragmented and marginal in size, typically less than one acre per household. The majority of affected families belong to tribal and indigenous communities, with limited savings and high dependence on natural resources.

The landslides stripped away topsoil across large areas, rendering the land unsuitable for cultivation in the near term. In many locations, farmland has either been buried under debris or completely

washed away. Houses located on or near agricultural plots were also destroyed, forcing families to relocate. Most displaced households have been moved approximately 8 km away from the landslide sites, to areas where they still retain some land rights. However, access to these lands is constrained, and productive use remains uncertain due to damage to soil, water sources, and connectivity.

Beyond livelihoods and shelter, the disaster has disrupted access to basic services. Health facilities and schools in the affected areas were damaged or rendered inaccessible, interrupting service delivery and schooling. Drinking water sources, including springs and small gravity-fed systems, were either contaminated or destroyed by debris flows, increasing reliance on temporary water supply arrangements and raising public health concerns.

Overall, the July 2024 Wayanad landslides highlight the compounding risks faced by smallholder and indigenous communities living in ecologically fragile, high-rainfall regions. The event underscores the need for integrated adaptation investments that address slope stabilization, land and watershed management, resilient livelihoods, safe relocation planning, and restoration of essential services, alongside strengthened early warning and local preparedness systems.

Adaptation Priorities Identified- Officials emphasised that climate adaptation interventions in Wayanad must go beyond infrastructure and focus on human and livelihood dimensions. Priority areas identified included:

- Health and nutrition security
- Income stability and livelihood diversification
- Drinking water security
- Climate-resilient livelihood options, including agri-based and non-farm alternatives
- Disaster risk reduction and insurance mechanisms, including parametric insurance, anticipatory actions and early warning systems (EWS)
- Value addition and market-linked interventions to improve farm incomes

It was noted that Wayanad spans three to four distinct agro-ecological zones, and adaptation solutions must be tailored accordingly rather than applied uniformly across the district.

Ongoing Initiatives- Department representatives highlighted Conservatory Social Forestry initiatives, particularly in Kozhikode, where women's participation is being strengthened through Haritha Samitis, which are women-led community groups.

Eco-restoration efforts were also noted in abandoned quarry sites, aimed at restoring degraded landscapes while creating opportunities for community engagement and livelihood support.

Focus group discussion 2- Community-level FGD in Wayanad

Participants: 28

Key Problems Identified- Participants highlighted that climate change, combined with unsustainable land-use practices, is severely affecting agriculture, ecosystems, and livelihoods in the region. Forest areas have increasingly been converted into monoculture plantations, disrupting ecological balance and water systems. Changes in forest cover and hydrology are impacting wildlife behaviour, leading to greater human–wildlife conflict.

Agriculture has been significantly affected, with farmers reporting productivity losses due to pest infestations, particularly in crops such as pepper and coffee. These impacts have intensified in recent years, including following landslide events, which have further weakened soil health and farm resilience.

Severe soil erosion and declining soil fertility were repeatedly flagged as critical concerns. Participants noted that in several areas, topsoil has been almost completely washed away due to intense rainfall events, landslides, and poor land management practices. This has directly affected agricultural productivity and water retention capacity.

Water-related challenges emerged as a central issue. Erratic rainfall patterns, alternating dry spells and intense rainfall events, and unsustainable water extraction have led to water scarcity in dry periods and flooding during wet periods. Traditional water sources, including springs, are declining, while water availability is becoming increasingly unpredictable.

The spread of invasive species, particularly lantana, was identified as a major ecological threat. Participants noted that invasive species suppress native vegetation, increase fire risk, degrade soil quality, and have led to the disappearance of traditional and medicinal plant species.

Extreme weather events, including landslides, droughts, floods, and heat stress, are occurring with greater frequency and intensity. The eastern side of Wayanad was described as increasingly drought-prone, while the western side experiences more frequent flooding. Heat stress and emerging heat island effects were also flagged, particularly in built-up and plantation areas.

Livelihood insecurity was a recurring concern. Loss of agricultural income, crop damage, and declining ecosystem services have reduced household resilience. Participants also noted limited livelihood diversification options, increasing dependence on climate-sensitive agriculture, and rising economic stress.

Issues and Challenges Raised by the Community

Agriculture and Livelihoods

- Declining agricultural productivity due to increasing pest and disease infestations, especially in pepper and other crops
- Significant crop losses reported over the last 3 years, aggravated after landslide incidents
- Unsustainable agricultural practices, including excessive agro-chemical use, affecting soil health and yields
- Traditional agricultural practices and indigenous knowledge are gradually being lost
- Loss of livelihoods and income due to reduced farm output and land degradation



Soil, Water, and Land Degradation

- Severe soil erosion and loss of fertile topsoil, in some areas completely washed away
- Landslides and debris flows damaging agricultural land and settlements
- Unsustainable water extraction and unscientific water conservation practices threatening future water availability
- Water scarcity during dry days and erratic, intense rainfall during wet days
- Changes in water flow patterns, increased runoff, and reduced groundwater recharge

Climate and Environmental Changes

- Erratic rainfall patterns and extreme variations in temperature
- Increased frequency of floods on the western side and drought conditions on the eastern side
- Heat island effects and rising local temperatures
- Climate change impacts combined with unsustainable practices affecting forest and natural resources

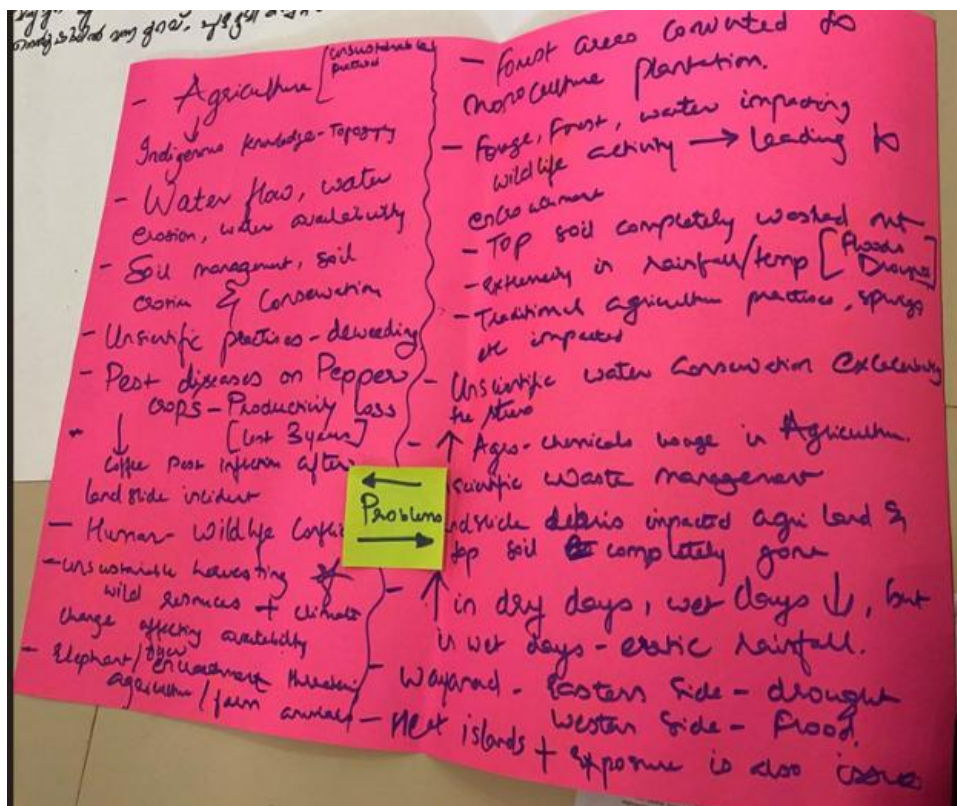
- Expansion of monoculture plantations leading to forest area loss

Forests, Biodiversity, and Wildlife

- Forest degradation due to overuse and unsustainable harvesting of wild resources
- Increased human-wildlife conflict, including crop damage and threats to livestock and farm animals
- Wildlife habitat disturbance caused by land-use change and infrastructure damage from landslides
- Spread of invasive species affecting native ecosystems and agricultural land

Social and Institutional Challenges

- Limited access to insurance and risk-sharing mechanisms for farmers
- Lack of training and capacity building on sustainable agriculture, soil conservation, and water management
- Fragmented interventions and absence of an integrated, landscape-level approach



Drivers and Underlying Causes- Participants linked many of these challenges to unsustainable agricultural practices, including excessive use of agro-chemicals, unscientific water conservation measures, and poor soil management. Traditional agricultural practices and indigenous knowledge systems, which are better adapted to local topography and climate variability, were reported to be eroding.

Poor waste management, particularly after extreme events such as landslides, was identified as exacerbating soil and land degradation. Debris and unmanaged waste were reported to contaminate agricultural land and water sources.

Institutional gaps were also highlighted, including limited coordination across sectors, insufficient extension support, and inadequate access to training, finance, and climate information for farmers and local communities.

Solutions and Priority Interventions Suggested- Participants strongly emphasised the need for an integrated, landscape-based approach to adaptation. Ecosystem restoration was identified as a priority, including soil conservation and restoration, reforestation with native species, and removal of invasive species.

Water management interventions were highlighted as critical, including spring rejuvenation, watershed restoration, improved rainwater harvesting, and protection of natural drainage systems. Participants stressed that water solutions must be linked to land-use planning and ecosystem health.

There was strong support for promoting alternative and diversified agri-based livelihoods to reduce dependence on climate-vulnerable farming systems. Non-farm livelihood options, value addition, and nature-linked enterprises were seen as important pathways for resilience.

Capacity building and training were identified as cross-cutting needs. Participants highlighted the importance of training farmers, local institutions, and extension workers on climate-resilient agriculture, soil and water management, and sustainable livelihood practices. Training-of-trainers models were suggested to enable scale.

Strengthening climate resilience and DRR financing mechanisms was also discussed, including improved access to insurance, credit, and public schemes for adaptation and recovery.

Participants highlighted the importance of integrating indigenous knowledge, traditional practices, and community-led conservation approaches into project design. These were seen as essential for long-term sustainability and local ownership.

Cross-Cutting Themes- A strong consensus emerged on the need for convergence across sectors, including agriculture, forestry, water, disaster management, and livelihoods.

Social inclusion was implicitly highlighted, with recognition that small and marginal farmers, forest-dependent communities, and vulnerable households face disproportionate climate impacts and should be prioritised in adaptation planning.

Photographs



Consultation 4- District-level and Community-level Stakeholder Meeting- Gudalur, Ooty in Nilgiris and Coimbatore

Focus group discussion 1- Community level in Gudalur

Landscape: Gudalur in Nilgiris, Tamil Nadu

Socio-Economic Profile of Communities- A large proportion of households do not own land and are fully dependent on daily wage labour for survival. The absence of land ownership or formal land titles significantly constrains livelihood security and access to institutional support. Communities reported extremely low savings levels and limited capacity to absorb financial shocks.

Due to the lack of land titles, households are unable to access formal loans or credit facilities, further restricting investment in livelihoods. Over the past seven to eight months of heavy rainfall, income opportunities have declined sharply, particularly for wage labourers. Most households reported having no financial buffers, increasing vulnerability to climate-related shocks and disruptions.

Livelihood Patterns & Constraints- Primary income sources include daily wage labour, plantation work, and limited engagement in minor forest-based activities. Opportunities for micro-farming are constrained by land scarcity, wildlife movement into cultivated areas, and increasing climatic uncertainty, making agricultural investment risky for land-poor households.

Collection of non-timber forest products remains minimal, with honey being the primary NTFP collected. Although medicinal plants are present in forest areas, they remain largely underutilised due to weak access mechanisms, lack of value chains, and limited market knowledge. Communities emphasised that while natural resources are abundant, access and economic value remain constrained, and there is strong interest in alternative livelihoods linked to conservation and ecological restoration.

Human–Wildlife Conflict (HWC)- Human–wildlife conflict was identified as a major and escalating challenge, with frequent crop damage and safety risks. The main conflict species reported include elephants, and other wildlife such as leopards. Participants attributed increasing conflict to habitat fragmentation, spread of invasive species, and reduced availability of native forage within forest interiors. Elephant movement into settlements has intensified due to the loss of large native trees and shrinking forest habitats. While solar fencing has helped reduce conflict in certain locations, communities noted that it is not fully effective, as elephants quickly adapt to deterrent measures.

Compensation & Institutional Response- Government compensation mechanisms exist for crop and livestock damage caused by wildlife. However, participants reported that compensation is frequently delayed and that crop damage assessment processes are often inadequate or inconsistent.

Lack of land ownership further complicates access to compensation, particularly for landless households and informal cultivators. Communities stressed that compensation alone is insufficient and must be complemented by viable livelihood alternatives to address the root causes of vulnerability.

Forest Fires & Seasonal Risks- The period from December to March was identified as a high-risk season for forest fires, coinciding with critical bird nesting and breeding periods. Participants noted that approximately 90 percent of forest fires are ground fires, and that most are anthropogenic in nature, often caused accidentally.

Climate-related factors such as faster drying of grasslands and longer dry spells were reported to be worsening fire risk. Smoke from fires affects both human health and visibility, disrupting daily activities. Communities emphasised the need for proactive fire prevention measures rather than reactive responses.

Climate Change Impacts (Observed)- Participants reported an increase in both the intensity and duration of rainfall events in recent years. These changes have contributed to landslides during recent monsoons, resulting in damage to housing and local infrastructure. Some affected households were rehabilitated, while others were shifted to temporary shelters. Extreme weather events have also disrupted access and services, with roads frequently damaged or blocked. Children were required to stay in schools during periods of unsafe travel, and power and electricity connections were disrupted during extreme rainfall events.

Access to Services & Infrastructure- Villages reported poor road connectivity and limited access to essential services. The nearest hospital is located approximately six kilometres away, and public transport options are limited, resulting in reliance on private vehicles. Snake bites were identified as a common risk, particularly during the monsoon season. The Forest Department has installed solar lights along forest roads and solar fencing in conflict-prone zones, which communities acknowledged as useful interventions, though gaps in coverage remain.

Restoration & Ecological Management- Participants reported ongoing efforts to remove *Lantana camara*, with mapping conducted in 2017 and removal activities initiated around 2015. Awareness activities and exhibitions were also organised in 2017 to highlight the impacts of invasive species. (Total land area: 1100 Ha)

Communities stressed that invasive species removal must be followed by active ecological restoration. Planting native grasses and fodder species was identified as essential to prevent reinvasion. Participants highlighted that restoration could reduce wildlife movement into villages, improve ecosystem health, and create local employment opportunities.

Community Engagement & Employment- Communities strongly emphasised the importance of engaging local people directly in restoration and conservation activities. Linking ecological restoration to paid employment was seen as critical for building ownership and ensuring sustainability.

Currently, approximately 48 people are engaged in certain activities, with plans to expand engagement to around 525 individuals. The long-term aspiration is to transition from short-term wage labour to sustained, dignified livelihoods linked to ecosystem management.

Gender & Social Dimensions- Women are heavily dependent on daily wage labour and are particularly vulnerable to income disruptions during climate shocks. Participants identified women-led activities such as NTFP processing, nursery raising, and lemongrass-based enterprises as promising livelihood pathways.

However, women reported increased workloads during climate-related disruptions and limited access to decision-making spaces. Strengthening women's participation and leadership was identified as essential for equitable and resilient outcomes.

Intergenerational Concerns- Participants expressed concern that younger generations are becoming increasingly vulnerable due to declining access to land and forest resources. Earlier generations were perceived to have greater livelihood security through land ownership or forest access, which is no longer available to many households.

There was a strong desire to secure future livelihoods for younger generations through restoration-linked employment and long-term livelihood pathways that reduce dependency on precarious wage labour.

Photographs



Focus group discussion 2- Community level FGD in Nilgiris

Location: Nilgiris landscape

Community Profile- The communities are predominantly dependent on rainfed agriculture, with strong reliance on surrounding forests and non-timber forest products (NTFPs) for subsistence and supplementary income. Forests play a critical role in sustaining livelihoods, food security, and household energy needs. However, this high dependence also increases vulnerability to ecological degradation and regulatory restrictions on forest access.

Communities reported high exposure to climate variability, human–wildlife conflict, and land-use constraints. While livelihoods are diversified across agriculture, forest-based activities, and wage labour, they remain fragile and highly sensitive to environmental and climatic shocks.

Agriculture & Livelihood Systems- Livelihood systems are centred around rainfed agriculture, forest produce collection, and wage labour, with emerging activities such as beekeeping observed in some areas. Major crops include coffee, pepper, millets, maize, and jackfruit, reflecting both commercial and subsistence priorities. Approximately 500 households depend directly or indirectly on agriculture and forest-based livelihoods across the study area.

Participants highlighted that these livelihood systems are increasingly under stress due to unpredictable rainfall patterns, declining soil fertility, and persistent water scarcity. These pressures are reducing productivity, increasing income uncertainty, and undermining traditional coping mechanisms.

Climate Change Impacts- Participants consistently reported noticeable changes in local climate patterns, particularly erratic monsoon behaviour characterised by delayed onset and short periods of intense rainfall. Rising temperature extremes were also noted, affecting crop growth and labour productivity.

These climatic changes have resulted in increased crop losses, more frequent landslides, and accelerated soil erosion. Communities emphasised that climate change is disrupting traditional cropping calendars, shortening recovery cycles, and reducing the reliability of previously stable agricultural practices.

Soil & Water Challenges- Declining soil health emerged as a major concern, with participants reporting soil acidification in certain areas and a general loss of organic matter. These changes have reduced soil productivity and increased dependence on external inputs, despite limited financial capacity among smallholders. Water availability remains highly constrained, with limited groundwater resources and no assured water sources in many villages. Reduced water infiltration was linked to forest degradation and the spread of invasive species, further exacerbating water insecurity for both agricultural and domestic use.

Forests, Biodiversity & Ecology- Forests continue to provide critical ecosystem services, including water regulation, soil protection, and livelihood support. Communities demonstrated a strong understanding of the ecological importance of forests and biodiversity for long-term resilience.

However, key challenges include the spread of invasive species, rising human–wildlife conflict, and restricted access to forest resources due to regulatory frameworks. Participants expressed that while conservation objectives are important, communities often feel excluded from decision-making processes related to forest management.

Human–Wildlife Conflict- Human–wildlife conflict has increased significantly in recent years, with frequent crop damage reported across villages. Wildlife incursions are particularly damaging for food crops, resulting in substantial livelihood losses for smallholders.

Participants noted that compensation mechanisms are often delayed or insufficient, discouraging continued cultivation. In some cases, farmers have reduced or abandoned food crop cultivation altogether due to repeated losses and lack of effective mitigation measures.

Gender Dimensions- Women play a central role in agriculture, particularly in millet cultivation and household food security. Millets were repeatedly described as “women-managed crops”, with women responsible for seed selection, cultivation, processing, and storage.

Despite this, women reported limited access to training, extension services, and formal institutional support. Confidence, leadership opportunities, and representation in decision-making spaces remain low. Participants strongly emphasised the need for targeted training programmes, leadership development, and greater recognition of women’s role in climate resilience.

Beekeeping & Biodiversity-linked Livelihoods- Beekeeping was identified as an important biodiversity-linked livelihood with benefits for income diversification and crop pollination. Historically, it has contributed to household earnings and ecosystem health.

However, participants reported a decline in beekeeping due to disrupted flowering cycles, climate stress, and changes in cropping systems. There was strong interest in reviving beekeeping through technical support, training, and improved market linkages.

Food & Nutrition Security- Declining agricultural yields are directly affecting household food availability and dietary diversity. Reduced cultivation of traditional crops, particularly millets, has increased dependence on market-purchased food, exposing households to price volatility.

Food security concerns were reported to be particularly acute for women-led households, where limited income, water scarcity, and caregiving responsibilities compound vulnerability.

Insurance & Risk Management- Awareness of existing crop insurance schemes remains limited, with very few households enrolled. Knowledge of parametric or soil-based insurance mechanisms was particularly low.

There was clear interest in insurance products that are accessible to smallholders, reflect local climate risks, and offer timely payouts in the event of climate shocks or crop failure.

Key Community Priorities- Communities prioritised restoration of soil and water systems as a foundation for livelihood security. Promotion of millets and other climate-resilient crops was identified as critical for food security and resilience.

Additional priorities included strengthening women-led livelihoods, reviving biodiversity-linked activities such as beekeeping, reducing human–wildlife conflict, and improving institutional support and coordination.

Photographs



Focus group discussion 3- Community level FGD in Coimbatore

Community Profile- The communities consulted are predominantly tribal settlements, with one cluster comprising approximately seven tribal settlements and around 285 families. Livelihoods are closely tied to natural resources, with households relying on agriculture, livestock rearing, and forest produce for subsistence and income. Forests play a central role in daily life, providing fuel, fodder, and minor forest produce, particularly during lean agricultural periods.

Education levels vary across households. While access to schooling exists, several participants noted that many students are first-generation learners, including those pursuing higher education. Educational continuity is often affected by livelihood pressures and water scarcity, particularly for children involved in household responsibilities.

Land, Agriculture, and Livelihoods- Landholdings across the villages are generally small, typically ranging between one and three acres. Agriculture is largely rainfed, making livelihoods highly vulnerable to rainfall variability. Paddy, millets, and ragi are the primary crops cultivated, reflecting both traditional practices and adaptation to local agro-climatic conditions.

Community members reported a gradual shift away from chemical-based farming towards organic practices in recent years. Despite this transition, agricultural productivity has declined due to reduced soil fertility and increasing soil erosion. The spread of invasive species such as lantana has further constrained both agricultural land and access to forest areas, with removal requiring significant labour inputs on an annual basis.

Water Availability and Drought- Water scarcity emerged as one of the most critical issues across all discussion. In several hamlets, drinking water sources are located two to three kilometres away, requiring daily travel. Water availability is highly seasonal, with most sources sustaining communities for only two to three months following the monsoon.

Households depend on a combination of check dams, rivers, streams, and dam releases. Participants highlighted uneven access to treated water, with some settlements relying on filtered supply while others depend on untreated sources. Increasing drought frequency has intensified stress on these already limited water systems.

Gendered Impacts- Women bear a disproportionate burden of water scarcity. FGDs revealed that women spend several hours each day collecting water, often walking long distances, which adds to physical strain and reduces time available for income-generating activities or rest. This daily responsibility significantly affects women's health and well-being.

Girls and children are frequently involved in water collection, particularly during dry months. This affects school attendance and study time, reinforcing intergenerational vulnerabilities. Inadequate water availability also constrains sanitation practices, with toilet usage becoming difficult during periods of acute scarcity.

Forest Use, Conservation, and Governance- Communities reported strong dependence on forests for livelihoods, including fuelwood, fodder, and minor forest produce. However, participants noted visible forest degradation and a decline in the availability of forest resources over time, which has increased livelihood insecurity. There is strong community interest in forest regeneration, particularly through planting native species and improving forest maintenance. At the same time, gaps were identified in awareness of governance mechanisms, including grievance redressal processes, access rights, and benefit-sharing arrangements linked to forest management.

Income, Markets, and Value Chains- Both agricultural produce and forest-based products currently fetch low market prices, limiting income potential. Communities attributed this to the absence of organised aggregation systems, inadequate storage facilities, and weak market linkages.

Participants expressed interest in structured forest produce collection, value addition, and improved access to markets. There was a strong emphasis on increasing productivity and income in ways that remain environmentally sustainable and compatible with forest conservation goals.

Health, Nutrition, and Social Aspects- Community members observed a decline in nutrition outcomes over recent years, linked to reduced rainfall, lower agricultural yields, and declining forest produce availability. Food insecurity was identified as a growing concern, particularly for vulnerable households.

Health services are accessed primarily through nearby primary health centres. However, distance, limited transport options, and water scarcity constrain regular utilisation of these services, especially for women, children, and the elderly.

Community Priorities and Suggested Solutions- Water security emerged as the foremost priority across all FGDs. Communities emphasised the need for strengthening existing check dams, constructing new water storage structures, and ensuring regular maintenance to improve year-round availability.

Participants also prioritised forest regeneration using native species, support for organic farming, soil restoration measures, and management of invasive species. Livelihood diversification through forest-based enterprises and improved agricultural value chains was seen as essential for long-term resilience.

Key Cross-Cutting Issues- Across discussions, climate variability and increasing drought frequency were identified as underlying stressors exacerbating livelihood vulnerability. High dependence on natural resources without adequate institutional support has heightened exposure to environmental and economic shocks.

Gender-differentiated impacts, particularly related to water access, require targeted interventions. Despite these challenges, communities demonstrated strong willingness to participate in conservation-linked livelihood programmes and collective resource management initiatives.

Photographs



BOX-1:

As part of ongoing livelihood diversification initiatives, both Tamil Nadu and Kerala are promoting small enterprises that utilise harvested *Lantana camara* stems for value-added products. These include handcrafted decorative items, such as animal figurines (notably elephants), for which export-oriented market linkages, particularly to European buyers, have been established. In Gudalur, community engagement has thus far focused primarily on lantana clearance activities that provide wage-based employment. However, there is clear potential to transition these efforts toward community-managed enterprise models that generate sustained livelihood opportunities through processing and product development.

In addition, a lantana briquetting unit in Gudalur, with an installed capacity of approximately 8 tons per day, is fully operated and managed by women's groups. The unit currently supplies briquettes to local tea factories for use in CTC tea processing. A detailed assessment of the plant's

technical and economic viability is important for determining its scalability, financial sustainability, and potential for replication within community-led business structures.

In parallel, the Tamil Nadu Forest Department has deployed AI-enabled thermal camera systems in selected locations to support early detection and monitoring of elephant movement, with the objective of reducing human–elephant conflict and associated livelihood risks.

Annex 1: Guiding questionnaire for local-level stakeholder meetings

Village-level consultations will be undertaken through Focus Group Discussions (FGDs), with one to two FGDs conducted per location, to verify findings and gather additional community perspectives, subject to time availability. Discussion themes will remain flexible and will be adapted based on participants' knowledge, emerging issues, and local priorities identified during the meetings. Information will be gathered in the following template and various discussion themes and guiding questions are highlighted below.

Field	Details
Meeting facilitator/ Moderator	
Note Taker / Recorder	
Location /District/ Village	
Date	
Duration	
Stakeholder present	
Consultation mode	Local-level stakeholder meeting

A. Discussion themes and guiding questions for FGDs.

1. Climate change and local Risks

- What are the most pressing climate-related risks in your district/community? (e.g., floods, droughts, landslides, heatwaves)
- Have you noticed changes in rainfall patterns, temperature, or frequency of extreme events over the last 10–20 years?
- Which extreme events are most common and damaging now? Rank top 3 risks
- Have you observed flash floods, landslides, or erosion in your area? Are there new areas prone to slope failure or soil piping?

2. Livelihoods and socio-economic impacts

- How have floods, landslides, or droughts affected crop yields, livestock, or forest-based livelihoods?
- Which areas in or around your community/ districts are most affected by crop loss, soil erosion, or reduced forest products?
- When climate shocks occur, do village communities/ households take on debt or sell assets to recover?
- Does lack of formal land titles limit access to credit, insurance, or government support?
- Are other livelihoods affected (livestock, forest produce, wage labor)?
- What government support has been received in the region?

3. Vulnerable groups and livelihoods

- Which communities or groups are most vulnerable? (Women, PVTGs, smallholders, elderly, youth)
- How have these groups been affected in terms of income, food security, and livelihoods?

- Are there tribal/IPLC settlements particularly affected or underrepresented?
- Are there areas with frequent conflicts over water, land, or forest resources?
- How does youth or adult migration affect women, elders, and PVTGs' adaptive capacity?
- How do climate impacts affect women specifically? (Workload, access to credit/training, participation in decision-making, health, time for fetching water/firewood)
- What priority interventions would most help these groups cope with climate risks?

4. Water resources and availability

- Are local streams, springs, or wells drying up earlier than before?
- Have downstream wells experienced salinity or reduced flows?
- How are households coping with water scarcity? (storage, rationing, community management)
- Are traditional aquifers or spring systems under threat?
- Have you noticed water quality changes (e.g., brackish water in downstream wells)?
- Are there critical water points for households that should guide site selection?

5. Forests, wildlife and biodiversity

- Are there areas where invasive plants (Lantana, Senna) dominate and block native regeneration?
- Are there forests or biodiversity hotspots in or around your areas at risk that should be included in restoration efforts?
- Have wildlife corridors been disrupted, or have human–wildlife conflicts increased?
- Are NTFPs (firewood, food, medicinal plants) availability changing?

6. Governance and coordination

- How are climate and disaster risks currently managed at district and local levels?
- Are coordination mechanisms in place between government, CSOs, and community groups? Are there cross border coordination issues?
- What gaps or barriers exist for effective governance and climate adaptation planning?
- Are there roads, bridges, or paths in certain areas that are cut off during rains, affecting access to markets, hospitals, or emergency services?
- Are there local committees/Panchayats active in resource/climate management?
- Are monitoring systems in place for water, forest health, or biodiversity?
- Are there conflicts over resource access? Frequency, type, and parties involved?

7. Adaptation and coping strategies

- What strategies are currently being used to cope with climate impacts?
- Which strategies has been effective and which have not?
- Are there gaps in technical support, financial resources, or access to climate information?
- Are there areas where communities are most willing or capable of adopting new climate-smart practices?

8. Health, education & community life

- Are some areas more affected by heat-related illness, malnutrition, or missing school due to climate impacts?
- Have tribal or marginalized communities experienced specific health or education impacts due to climate stress?

9. **Project priorities and site selection**

- Based on all the challenges discussed, which areas or villages do you think should be prioritized for support? Why?
- Are there sites where previous projects worked well or failed?
- Where can the project make the most impact quickly and sustainably?

Annex 2: FPIC Consent Recording Template

FPIC CONSENT RECORDING TEMPLATE
<i>(For Indigenous Peoples / Indigenous Peoples and Local Communities)</i>
A. General Information
Project Title: <i>Enhancing Climate Resilience and Biodiversity Conservation in the Nilgiri-Wayanad-Chaliyar Corridor</i>
Implementing Entity / Organization: UNEP
Consultation Type: ☐ FGD ☐ Community Meeting ☐ PRA Exercise ☐ Other: _____
Location (Village / District / Country):
Date of Consultation:
Duration: From _____ To _____
Language(s) Used:
Facilitator / Moderator Name(s):
Note Taker / Recorder:
B. Information Shared With Participants
<i>(Tick all that apply)</i>
☐ Project objectives and scope
C. Statement of Free, Prior and Informed Consent
<i>The undersigned / participants confirm that the project information was explained clearly and in a language and manner that was understandable. Participation in this consultation was voluntary and free from coercion. Adequate time was provided for questions, discussion, and internal deliberation. Based on this understanding, the community expresses its position as recorded below.</i>
D. Community Decision
<i>(Select one and complete details)</i>
☐ Consent Granted The community agrees to the project proceeding as presented and discussed.

☐ Audio recording (if consented) ☐ Separate women's / vulnerable group consultation notes
I. Commitment to Ongoing FPIC
<i>The project recognizes FPIC as an ongoing process. Additional consultations will be undertaken if project activities, scope, or impacts change materially during implementation.</i>

UNEP		Place:	Date:	
Topic/ Purpose of meeting: Consultation on Project design-Enhancing Climate Resilience and Biodiversity Conservation in the Nilgiri-Wayanad-Chaliyar Corridor				
FPIC Validation Statement: Participants confirmed that the purpose, proposed activities, potential benefits, and risks of the project were clearly explained and understood. Participants agreed that the consultation was conducted freely, prior to project finalization, and in an inclusive manner. Community representatives expressed their consent for the project to proceed as discussed, subject to the incorporation of the agreed priorities and safeguards.				
Name	Representing	Contact details	Gender	Signature

- o Women
- o Indigenous Peoples / IPLCs/Farmers / forest users/Youth / elders
- Ensure representation of vulnerable and marginalized groups

2. Logistics

- Neutral, accessible venue (community hall, school, shaded outdoor space)
- Local language facilitator
- Gender-appropriate facilitation where required
- Obtain Free, Prior and Informed Consent (FPIC) upfront (explain purpose, voluntary nature, use of data)

3. Team roles

- Facilitator/moderator
- Note-taker (plus audio recording if consented)
- Timekeeper (optional)

C. Conducting the FGD (90 minutes)

Step 1: Opening (10 min)

- Introductions (name, role, village)
- Explain:
 - o Purpose of discussion
 - o No right or wrong answers
 - o Confidentiality and voluntary participation
- Ground rules (respect, one person at a time)

Step 2: Thematic discussion (60–90 min)

Use open-ended questions, probing gently. Themes typically include:

- Climate risks and changes observed
- Livelihood impacts
- Water, forests, land, biodiversity
- Vulnerable groups
- Existing coping strategies
- Governance and institutional gaps
- Priority needs and sites

👉 Use ranking, voting, or simple scoring to prioritize risks or interventions.

Step 3: Validation & closure (10–15 min)

- Summarize key points back to participants
- Ask: *“Did we capture this correctly?”*
- Thank participants and explain next steps

D. Facilitation Tips

- Avoid domination by local elites
- Encourage quieter participants
- Use local examples and timelines (“before 10 years / now”)
- Be neutral—do not promise benefits

E. Outputs

- FGD summary notes
- Ranked risks and priorities
- Quotes illustrating community perspectives
- List of suggested sites/interventions
- Issues requiring follow-up

2. Participatory Rural Appraisal (PRA):

PRA complements FGDs by using visual, interactive tools that reduce literacy barriers and power imbalances.

A. When to Use PRA

- Mapping climate risks and resources
- Understanding spatial vulnerability
- Exploring seasonal patterns
- Identifying institutional and social dynamics

B. Core PRA Tools (Practical Use)

1. Social & Resource Mapping

How

- Ask participants to draw their village on the ground or paper
- Mark:
 - o Houses, farms, forests, water sources
 - o Flood/landslide-prone areas
 - o Degraded lands
 - o Critical infrastructure

Use for

- Site selection
- Identifying high-risk zones
- Understanding access and exclusion

2. Seasonal Calendar

How

- Draw months on a chart
- Ask participants to mark:
 - o Rainfall
 - o Crop cycles
 - o Water availability
 - o Disease incidence
 - o Migration

Use for

- Timing interventions
- Understanding climate stress periods
- Designing livelihood support

3. Historical Timeline

How

- Ask community to recall major events over 10–30 years
- Mark floods, droughts, forest loss, policy changes

Use for

- Demonstrating climate trends
- Linking impacts to adaptation needs

4. Problem Ranking / Matrix Scoring

How

- List key problems identified
- Use stones/seeds to score severity or frequency

Use for

- Prioritization
- Justifying intervention focus to donors

5. Institutional / Venn Diagram

How

- Draw circles representing institutions (Panchayat, Forest Dept, NGOs)
- Size = importance, distance = accessibility

Use for

- Governance analysis
- Identifying coordination gaps

C. PRA Facilitation Tips

- Let community members lead the drawing
- Avoid correcting or “improving” maps
- Photograph outputs (with consent)
- Cross-check findings with FGDs and key informant interviews

D. Outputs

- Maps, calendars, diagrams (photo-documented)
- Clear understanding of spatial and seasonal vulnerability
- Community-defined priorities
- Strong justification for project design choices

3. Activity: Community Objective Setting Workshop

(“From Problems to Objectives”)

Purpose

To jointly identify, prioritize, and validate clear project objectives that:

- Respond to locally identified climate risks
- Reflect community priorities (including women and vulnerable groups)
- Are feasible, measurable, and fundable

Duration

60 minutes

Participants

- 10–20 participants
- Mix of:
 - o Women and men
 - o Vulnerable groups / IPs
 - o Local leaders / Panchayat reps
- Facilitator + note-taker

Step-by-Step Activity Design

Step 1: Recap Key Problems (15 minutes)

Method: Plenary reflection

How

- Present (or restate verbally) the top 5–7 problems identified through FGDs/PRA (e.g. water scarcity, crop loss from floods, landslides, forest degradation)
- Ask participants:
“Do these reflect your main challenges? Is anything missing?”

Output

- Validated list of priority problems

Step 2: Problem → Objective Conversion (30 minutes)

Method: Small group work

How

- Divide participants into 3–4 small groups
- Assign each group 1–2 key problems
- Ask them to convert problems into positive change statements

Facilitator prompt

- “If this project is successful in 5 years, what will be different?”

Example

Problem	Objective (Draft)
Springs drying up	Improve year-round availability of safe water
Crop losses from floods	Increase climate-resilient agricultural production
Forest degradation	Restore and protect critical forest ecosystems

Output

- Draft objective statements (community language)

Step 3: Refining Objectives (25 minutes)

Method: Guided plenary discussion

How

Facilitator helps refine each objective using simple checks:

- Is it clear?
- Is it realistic within project duration?
- Does it address climate risk, not just development?
- Does it benefit vulnerable groups?

Facilitator tip

Avoid technical jargon—translate later for proposal writing.

Output

- 3–5 refined project objectives

Step 4: Prioritization & Consensus (20 minutes)

Method: Voting or scoring

How

- Give each participant 3 tokens/stickers
- Ask them to vote for objectives they see as most important
- Discuss results openly

Key question

“Which objectives should this project focus on first?”

Output

- Ranked list of project objectives
- Evidence of community prioritization

Step 5: Validation & FPIC Confirmation (10 minutes)

Method: Verbal confirmation

How

- Read out final objectives
- Ask:
“Do you agree these objectives reflect your priorities and consent to their use in the project design?”

Document

- Agreement / dissent
- Special notes from IPs or women’s groups

Output

- FPIC-compliant validation
- Final community-endorsed objectives

Example Final Output (CN-Ready)

Project Objective 1:

Strengthen climate-resilient water security for vulnerable households through restoration of springs and improved community water management.

Project Objective 2:

Enhance climate-resilient livelihoods by promoting flood- and drought-tolerant agricultural practices among smallholder farmers, with a focus on women and Indigenous communities.

Project Objective 3:

Restore degraded forest and slope ecosystems to reduce landslide and flood risks while improving biodiversity and ecosystem services.

Annexure-2

Community attendance in consultation and FPIC

Sl No	Name	Designation	Department	Mob.No	e-mail id	Signature
1	Dr. Rajiv Chandra	Project Scientist	Directorate of Fisheries	9445335295	shyamraj@fisheries.gov.in	
2	Nipar Lakshmi	Asst. Secretary	Gen. Board	7035509986	kanakalakshmi@gmail.com	
3	Anupama Reddy	Post Office, Tel. Bd.		995462749	anupama_bhat@gmail.com	
4	Dr. Jeyaraj, J	Gen. Officer, DSE	Department of Fisheries	80606152	jeyaraj.j@gmail.com	
5	Dr. S. S. S. V	Asst. Professor	Dr. J. S. S. V	9144348343	Sankaraj@vsnl.com	
6	Srinivas	RAO, SP, Kalyan	Police	944544578	Srinivas@kalyan.org	
7	C. Anurag Kumar	Asst. Sec. Engr., Dam & Water	KSEB	983337586	anuragkumar@kalyan.org	
8	Srinivas	Asst. Engineer, Mechanical	KSEB	905643333	Srinivas@kalyan.org	
9	Srinivas	Asst. Engineer, Civil	KSEB	905643333	Srinivas@kalyan.org	
10	Srinivas	Asst. Engineer, Civil	KSEB	905643333	Srinivas@kalyan.org	
11	Shubashini	Asst. Engineer, Civil	KSEB	905643333	Srinivas@kalyan.org	

Sl No	Name	Designation	Department	Mob.No	e-mail id	Signature
12	Keshav Das	Comm. Int.	MSP	98706012	Keshav@kalyan.org	
13	Flavia Lopes	Program Officer	UNEP	9144348343	flavia_lopes@unep.org	
14	Girish V.K.	Exe. Engineer	KSEB	9446008420		
15	Srinivas T	Asst. Engr.	KSEB	944744360		
16	Arjun Parameswaran	Field Officer	Spice Board	775645782		
17	R. K. Srinivas	Conservator, Social Forestry	Forest Department	6222005260	rk_srinivas@forest.gov.in	
18	Sivaram	Assistant Engineer	Soil Conservation Dept.	9446793876	sivaram@soil.gov.in	
19	Dr. Deepa K.R.	NPCIL, Model, B&B	D. M. C. B. & B. (KSEB)	9539774603	deepa@kalyan.org	
20	Jamey V. Mathew	Deputy Director	Rainy Development Department	9445503943	jamey@kalyan.org	
21	Manoj Kumar	JS	KSEB	9847600212	manojkumar@kalyan.org	
22	Dr. Vinod Kumar	Principal Scientist	Penula State (KSEB)	9446301070	vinodkumar@kalyan.org	

ATTENDANCE OF DISTRICT LEVEL STAKEHOLDER CONSULTATION WORKSHOP (UNEP ADAPTATION FUND PROJECT) HELD AT MESSRY ON 30-01-2026						
Sl No	Name	Designation	Department	Mob.No	e-mail id	Signature
23.	Dr. M. Narayanaswami	DD Office Boud		9446510118	Jde kalyanella@gmail.com	
24.	Sanjay P.R.	Director cum in-charge	KSPB	9155861414	sanjaycpr@kspb.kerala.gov.in	
25	Shreekanth	Bully	Bully unit	828109794		
26	Bimla K.G	"	Bully unit	9848978766		
27	Shaji KV	Programme Manager	seap	9495132214		
28	Sumesh K.V	Project Director	KSCSTE	9946605157		
29	Kuttan K	Asst. Director	SPECIAL BOARD SACM	789060192	Kuttan K SSB Gmail.com	
30	Dhanesh Kumar	Manager	RMS74	9895505601	dhanesh@rms74.com	
31	Rajya	Bully Reg.	Technician	9892888887		
32	Anila Anil	"	secretary	960537075		
33	Soujath	"		9605328732		

ATTENDANCE OF DISTRICT LEVEL STAKEHOLDER CONSULTATION WORKSHOP (UNEP ADAPTATION FUND PROJECT) HELD AT MESSRY ON 30-01-2026						
Sl No	Name	Designation	Department	Mob.No	e-mail id	Signature
34.	Manoj S	Asst. Secretary	'Produce' Panathery	9346057502		
35	Sajana	Bully unit/pollin and Pick-ups		9744123069		
36.	Ramkath	"		9947272132		
37.	Manojana	"		9136906908		
38	Beant Seshan	Secretary D.S. Panichayath	LCU	9921993201		
39	SEETHA S			9526192374		
40	E Suresh Babu	Asst. Secretary Kottayam District Museum		9455021023		
41	T.C JOSEPH	B.M.C	DT Secretary Kali Pottu	960507846		
42	Nikhil K.M	Bully Product (reg)	Bully unit	9847654574		
43	Pahama	Bully Reg	Bully Product	9747367748		
44	Selina D-mo	Asst. Secretary Kottayam District Museum	maine	9387422802		

ATTENDANCE OF DISTRICT LEVEL STAKEHOLDER CONSULTATION WORKSHOP (UNEP ADAPTATION FUND PROJECT) HELD AT MSSRF ON 30-01-2025						
Sl. No.	Name	Designation	Department	Mobile No.	e-mail id	Signature
15	Dr. Anika Allen	Secretary-B	CWRDM	8891019222	anika@cwrdm.org	
16	ANURAG. S. T.	Inspector		9544228590		
17	Latha - C		WTDC	960585542		
18	Sahadevas - K	Manager	water shed	7907777115		
19	Reshma AR	Head Climate Action	Water Control	9678069666	reshmaar@gnail.com	
20	Vaishna P	Research Officer Ecological Dept	Water Control	9328901016	vaishna.pst@gmail.com	
21	An - p. k	Program Officer	Sanitation Mission	985947834	an.priya@gmail.com	
22	Leela teacher	Rt-teacher	-	9605311074	-	
23	Chithra N K	Asst. Engineer	Water Control	9562342643		
24	E.M. Sajeer	Director WPM & Senior Deputy Chief	Trivandrum	9446949112	msajeer@gmail.com	
25	Savitri C	Inspector	Community	9443895605		

Sl No	Name	Designation	Department	Mob.No	e-mail id	Signature
56	Rafaela	Secretary MSPARD		9961367753		
57	Osha Ravi	General Manager		944107062		
58	Omara		WTO	9606440943		
59	Angel Abraham	Student	Biodiversity	9961316074		
60	Pranav P	DD Agri	Agrovet	944226 8058		
61	Zameer Bader DCE, Baid Tress	DCE Nalgondam	ICED	9447177154		
62	Pranab Kumar	Assistant Secretary	Antibacterial Communicable	9962669111		
63	Nandakumar M	Assistant Secretary	MSRF	949228089		
64	VIPIN RAS-P	"	MSRF	996591504		
65	A.K. Jyoti	Secretary MSRF	Forest	998845960		
66	Yash P	Assistant Secretary	MSRF	9961367753		

Sl No	Name	Designation	Department	Mob.No	e-mail id	Signature
67	Nandakumar	Member	MSRF	949228089		
68	Pranav P	Member	MSRF	944226 8058		
69	Sheena Shaji	Member	MSRF	944226 8058		
70	Vasanthakumari	Member	MSRF	944226 8058		
71	P. Srinivas	Member	MSRF	944226 8058		
72	R.C. Nagesh	Jr. Manager, L&D	MSRF	944226 8058		
73	Shafiqul Islam	Manager	MSRF	944226 8058		
74	Aravind	Manager	MSRF	944226 8058		
75	Aravind	Member	MSRF	944226 8058		
76	Aravind	Member	MSRF	944226 8058		
77	Nandakumar	Member	MSRF	944226 8058		

Annex-1:	Place:	Date:		
UNEP				
Topic/ Purpose of meeting: Consultation on Project design-Enhancing Climate Resilience and Biodiversity Conservation in the Nilgiri-Wayanad-Chaliker Corridor				
EPIC Validation Statement: Participants confirmed that the purpose, proposed activities, potential benefits, and risks of the project were clearly explained and understood. Participants agreed that the consultation was conducted freely, prior to project finalization, and in an inclusive manner. Community representatives expressed their consent for the project to proceed as discussed, subject to the incorporation of the agreed priorities and safeguards.				
Name	Representing	Contact details	Gender	Signature
Rabeem	Community Rep	9947367949	F	
Savitriy C	" "	9895875605	F	
Leela Teacher	" "	9605311094	F	
Souketh	Bailey Bags	9656323972	F	
Arifa Arif	" "	9605390283	F	
Rasika	" "	7592826082	F	
Sheena	member	9562811012	F	
Vasunthamani	member	9061263164	F	
Lajitha S	Kemba varanasi	9526172879	F	
Anitha K	Pailey bag	9847654534	F	
Rajini A R	Home centre for ecology	8078039635	F	
Vaishna Vasuki	Home centre for Ecology	9129990262	F	
Geetha N L	Puthoorvegal	9562342643	F	
Omara	Puthoorvegal	8606109943	F	
Latha C	Puthoorvegal	9605625947	F	
Namika V	Nammani Baijig	965639659	M	
P. Hanisham	Mundaki	9042926466	M	
Sahadevar	Mundaki	7907771115	M	
NOUFAK IS	Mundaki	954423225	F	
Shasha	bailey bag	8291097819	F	
Simi K B	bailey bag	9848976762	F	
Usharavi	Member	9544107062	F	
Rateena	Member	9947671503	F	
Sajina	Pailey bag	974462307	F	
Naseema	" "	" "	F	
Ranjith	" "	9947029232	F	



**Baseline analysis of climate risks and vulnerabilities,
including gender and marginalized groups vulnerabilities
in the wider Nilgiri-Wayanad-Chaliyar Corridor**

**Adaptation Fund single country concept “Enhancing community and ecosystem
climate resilience in the Nilgiri-Wayanad Corridor”**

Chapter 1: Introduction and Context

India is ranked 7th in the Global Climate Risk Index 2021¹, with its vulnerability stemming from a heavy reliance on climate-sensitive sectors and significant exposure to climate-related disasters. Over 80 percent² of the country's population lives in districts vulnerable to climate-induced hazards. Increasing temperatures, shifting rainfall patterns, falling groundwater levels, melting glaciers, stronger cyclones, and rising sea levels pose serious threats to livelihoods, food security, and the overall economy. Within this context and owing to its ecological sensitivity and increasing climate risks, the Western Ghats highlights the importance of prioritizing the region for focused climate adaptation planning and investment³.

The Western Ghats, a global biodiversity hotspot covering approximately 16,000 sq. km across six Indian states, is recognized as a UNESCO World Heritage Site. It supports over 7,400 species of flowering plants (around 1,700 endemic), 139 mammal species, including endangered species like the Lion-tailed macaque, Nilgiri tahr, and tiger, 508 bird species, with endemics like the Malabar grey hornbill and Nilgiri flycatcher and has rich diversity of reptiles, amphibians, and invertebrates⁴. The key forest types include tropical wet evergreen forests, the Montane shola-grassland ecosystems and others. As a hydrological heart or water tower of Peninsular India, this mountain range provides headwaters for major river basins and supplies up to 40% moisture on average which goes up to 50% in dry years⁵, sustaining both upstream and downstream communities.

Despite its ecological significance, the Western Ghats are increasingly vulnerable to climate change. Over the past five decades, the region has experienced a five-fold increase in extreme weather events, including rising temperatures, erratic monsoon patterns, frequent floods and landslides, and prolonged dry spells. Mean annual temperature in the Western Ghats is expected to rise by 1.5–2.0°C by 2050⁶, increasing heat stress and altering phenological cycles. In addition, the region also faces a number of other challenges such as livelihood challenges, encroachments and infrastructure issues and migration. Evidence suggests⁷ that delays in resilience-building measures could substantially escalate future economic and social costs.

¹ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

² United Nations Environment Programme (UNEP). (2025). Building Climate Resilient Villages: Village Adaptation and Development Action Initiative – Adaptation Fund Concept Note.

³ Ministry of Environment, Forest and Climate Change. (2013). *Report of the High Level Working Group on Western Ghats (Part I)*. Government of India. https://moef.gov.in/uploads/2021/08/1-HLWG-Report-Part-1_0.pdf

⁴ United Nations Environment Programme (UNEP). (2025). Building Climate Resilient Villages: Village Adaptation and Development Action Initiative – Adaptation Fund Concept Note.

⁵ Paul, S., Ghosh, S., Rajendran, K., & Murtugudde, R. (2018). Moisture supply from the Western Ghats forests to water deficit east coast of India. *Geophysical Research Letters*, 45(9), 4337-4344.

⁶ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁷ United Nations Environment Programme (UNEP). (2025). Building Climate Resilient Villages: Village Adaptation and Development Action Initiative – Adaptation Fund Concept Note.

The states of Tamil Nadu and Kerala, which share this ecological landscape, are among the most climate-vulnerable in southern India. Their vulnerability is driven by a combination of high sensitivity to climate variability and limited adaptive capacity, particularly among rural, agrarian, and forest-dependent populations. Tamil Nadu is a climate-vulnerable maritime state, frequently affected by rising temperatures, erratic rainfall, droughts, and sea-level rise, with profound implications for water security, agriculture, and coastal ecosystems. The state is heavily dependent on both the northeast (48%) and southwest (32%) monsoons⁸, making shifts in rainfall patterns especially disruptive. Currently, the frequency of intense rainfall events (above 64 mm/day) is projected to increase to 4–7 days per year by the end of the century⁹. Further, research indicates that in the Western Ghats of Tamil Nadu the habitat suitability for Evergreen and Deciduous forests is projected to decrease by 17% and 11% respectively by 2050¹⁰, while the area suitable for Thorn forests is expected to increase. This transition threatens endemic species and disrupts the hydrological regulation provided by these forests¹¹. Projections under the Shared Socio-economic Pathways (SSP5-8.5) scenario indicate a potential rise in annual mean maximum temperature by 3.5°C by the end of the century, with heatwave days increasing significantly¹². In response, climate action in the state is guided by the Tamil Nadu State Action Plan on Climate Change (TNSAPCC)¹³, which prioritizes sectors such as agriculture and forestry, and undertakes high-resolution climate risk assessments to inform district-level adaptation strategies. To enhance landscape-scale resilience, Tamil Nadu has launched initiatives such as Green Therapy¹⁴, which promotes nature-based solutions, comprehensive flood management, and cascading water tank systems to reduce downstream risks.

Kerala is similarly classified as a multi-hazard-prone state, uniquely exposed due to its location between the Arabian Sea and the steep escarpments of the Western Ghats. Approximately 15.7% of the state's land area is flood-prone, while 14.4% is susceptible to landslides, and around 36.6–40% of the coastline is highly vulnerable to erosion and sea-level rise. More than 70% of agricultural land is rainfed, heightening sensitivity to meteorological droughts. The increasing incidence of extreme rainfall, floods, landslides, and seasonal droughts, most notably the 2018 floods, has reshaped the state's approach to climate adaptation and disaster risk management¹⁵. Kerala has since strengthened its policy framework through SAPCC 2.0 (2023–2030), complemented by the Rebuild Kerala Initiative (RKI)¹⁶, which emphasizes risk-informed land-use planning and river basin management, as

⁸ Vidya, S., & Murthy, I. K. (2022). District-level changes in climate: Historical climate and climate change projections for the southern states of India. Centre for Study of Science, Technology and Policy.

⁹ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

¹⁰ Ibid

¹¹ Ibid

¹² Ibid

¹³ The Tamil Nadu State Action Plan on Climate Change (TNSAPCC) was endorsed by Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India (GoI) on 31st March, 2015.

¹⁴ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

¹⁵ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

¹⁶ Government of Kerala, State Planning Board. (2025). Economic Review 2024 (Vol. One). Thiruvananthapuram, Kerala, India: Government of Kerala

well as the Haritha Keralam Mission¹⁷, which integrates water conservation, organic farming, and waste management. Within the state, districts such as Wayanad and Kozhikode are recognized as vulnerability hotspots, with Wayanad having experienced a 62% loss in forest cover between 1950 and 2018, significantly heightening its exposure to landslides and agricultural stress.

Within the broader Western Ghats, the Wayanad–Nilgiris landscape constitutes a critical sub-landscape and forested watershed located at the junction of Kerala and Tamil Nadu. This area serves as the primary source for major river systems including the Bhavani, Chaliyar, and Kabani, forming a hydrological backbone that is essential for regional water balance. The landscape's steep and rugged terrain, combined with its dependence on stable monsoon patterns, makes it uniquely sensitive to climate change. Projections for the 2030s indicate rapid warming of 1.0–1.6°C, with nighttime temperatures increasing faster than daytime maximums, alongside a trend toward fewer rainy days but more intense rainfall events¹⁸. As much of the agriculture in this landscape is rainfed, even small deviations in rainfall have severe impacts. Climate change has also affected agricultural production in the region, which has traditionally been fertile and well-suited for plantations, millets, paddy, and horticultural crops. It has been noted¹⁹ that the eastern parts of the Western Ghats had already begun experiencing higher temperature rises (2.2°C maximum and 1.7°C minimum), and reduced rainfall by 20 %, impacting crop yields. Anthropogenic pressures have further weakened the adaptive capacity of this forested catchment, with the Western Ghats experiencing a 35.3% decline in forest cover over the past century²⁰. Forest fragmentation has disrupted slope continuity, contributing to increasingly fatal landslides, while unregulated development, including road construction on slopes steeper than 22 degrees and extensive quarrying, has destabilized the thin soil cover. The conversion of natural vegetation to plantations and built-up areas has also obstructed seasonal streams, reducing the landscape's ability to naturally regulate runoff during heavy rainfall events.

If forest degradation continues, the Wayanad–Nilgiris landscape faces a future of cascading environmental failure. Reduced forest cover limits soil absorption, increasing the velocity of surface runoff and triggering catastrophic landslides and flash floods, such as the 2024 Wayanad tragedy²¹. The loss of forest litter and root systems undermines groundwater recharge, leading to seasonal droughts and the drying of traditional springs. Biodiversity is also at risk, with projections indicating that evergreen forests in the Nilgiris and Coimbatore may decline by up to 32% by 2050²², gradually giving way to more arid forest types. Increased

¹⁷ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents

¹⁸ Ibid

¹⁹ Kumar, S. N., Aggarwal, P. K., Rani, S., Jain, S., Saxena, R., & Chauhan, N. (2011). Impact of climate change on crop productivity in Western Ghats, coastal and northeastern regions of India. *Current Science*, 332–341.

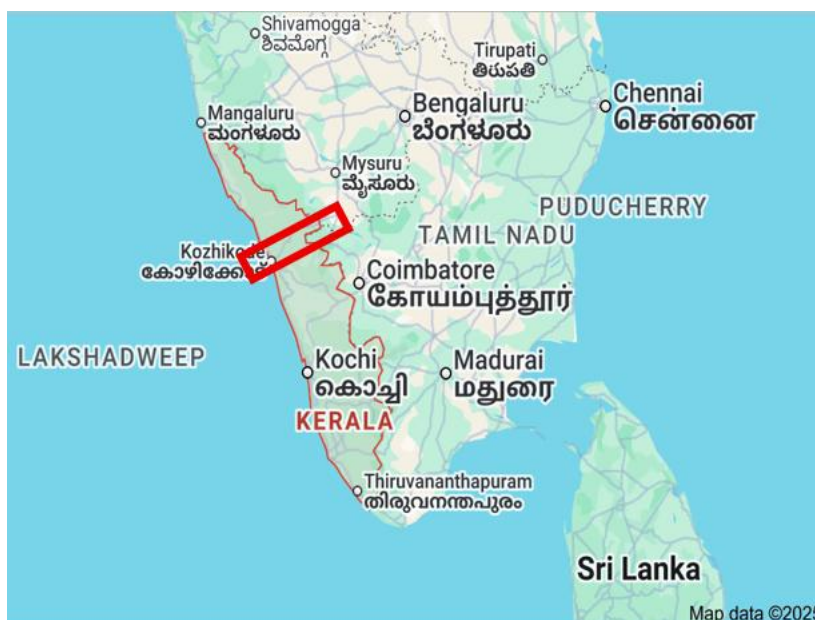
²⁰ Reddy, C. Sudhakar, C. S. Jha, and V. K. Dadhwal. *Assessment and monitoring of long-term forest cover changes (1920–2013) in Western Ghats biodiversity hotspot*. *Journal of Earth System Science* 125, no. 1 (February 2016): 103–114. Indian Academy of Sciences

²¹ Devastating landslides in Kerala's Wayanad district on July 30, 2024

²² Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). *Climate Risks Assessment and Adaptation Plan for Tamil Nadu – Forest Habitat Suitability* (Under Climate Studio)

upstream erosion is resulting in siltation of downstream reservoirs and riverbeds, reducing their carrying capacity and heightening flood risks for downstream communities in Kozhikode and Malappuram districts.

Map of the Nilgiris Chaliyar- Corridor - along with the Chaliyar River Basin



The Nilgiris-Chaliyar Corridor

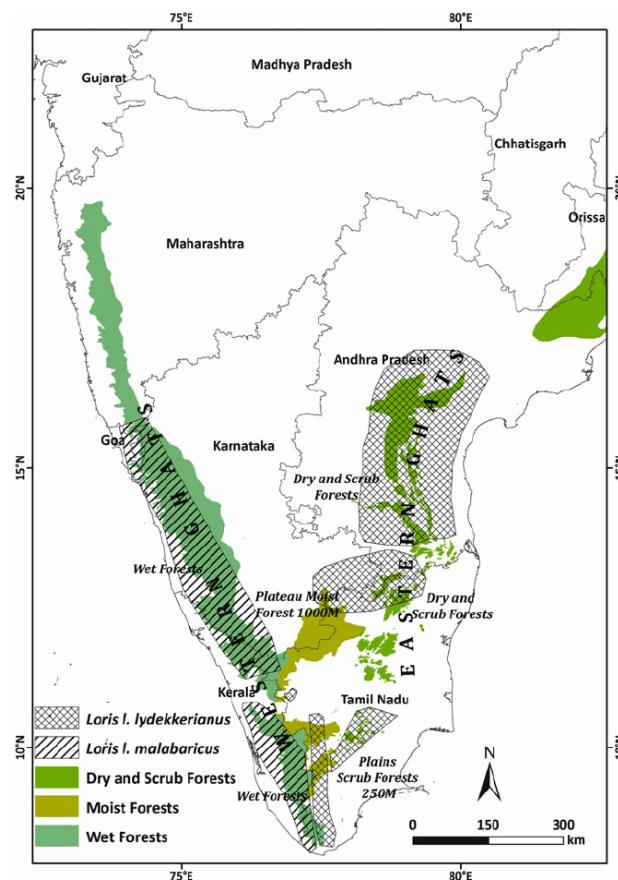
As high temperatures, droughts, forest fragmentation, and groundwater depletion increase, maintaining intact forested catchments becomes essential for ensuring water security, conserving biodiversity, and reducing disaster risks. The proposed intervention will focus on selected districts in Kerala (Wayanad, Kozhikode, Malappuram) and Tamil Nadu (Nilgiris, Coimbatore, Erode) within the Wayanad–Nilgiris highland arc of the Western Ghats. These districts are prioritized for their key forested catchments, water tower function, and shared ecological characteristics, including contiguous montane forests, steep terrain, and high biodiversity. Protecting and restoring this landscape is critical to safeguard livelihoods, stabilize soils, maintain hydrological balance, and strengthen resilience to increasing climate risks.

Chapter 2: Geographical, socio-economic, and environmental trends

2.1 Geographic scope and physical characteristics

- Broader geographical context: the Western Ghats

The Western Ghats are a globally significant mountain range that covers approximately 16,000 square kilometers and spans six Indian states: Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu. Running parallel to India's western coastline at a distance of roughly 80–160 kilometres from the sea, the range forms a continuous escarpment that exerts a defining influence on regional climate, hydrology, and ecosystems. Functioning as the primary watershed for Peninsular India, the forests of the Western Ghats supply an estimated 40% of the region's moisture on average, increasing to 50% during dry years²³, thereby regulating water availability across both windward and leeward landscapes.



Physically, the Western Ghats are characterized by steep slopes, deeply dissected valleys, and high relief, with elevations rising sharply from coastal plains to montane plateaus

²³ Paul, S., Ghosh, S., Rajendran, K., & Murtugudde, R. (2018). Moisture supply from the Western Ghats forests to water deficit east coast of India. *Geophysical Research Letters*, 45(9), 4337-4344.

exceeding 2,600 meters above sea level. The landscape features some of the highest peaks in India south of the Himalayas, including Anaimudi in Kerala²⁴, and Doddabetta and Mukurti, also in the Nilgiris. While largely continuous, the range is interrupted by major passes, including the Palghat Gap, a 30-kilometre-wide monsoon corridor²⁵, as well as the Shencottah, Aralvaimozhi, and Achankoil gaps, which strongly influence wind circulation, rainfall distribution, and temperature gradients across the region²⁶.

By intercepting moisture-laden monsoon winds, the Western Ghats generate high rainfall on their windward slopes, with annual totals commonly ranging between 2,000 and 3,000 millimetres, while simultaneously creating pronounced rain-shadow conditions to the east. This interaction between topography and monsoon dynamics underpins the Ghats' role as the hydrological lungs of southern India and as the source of major river systems, including the Bhavani, Chaliyar, Kabini, Moyar, and Vaigai.

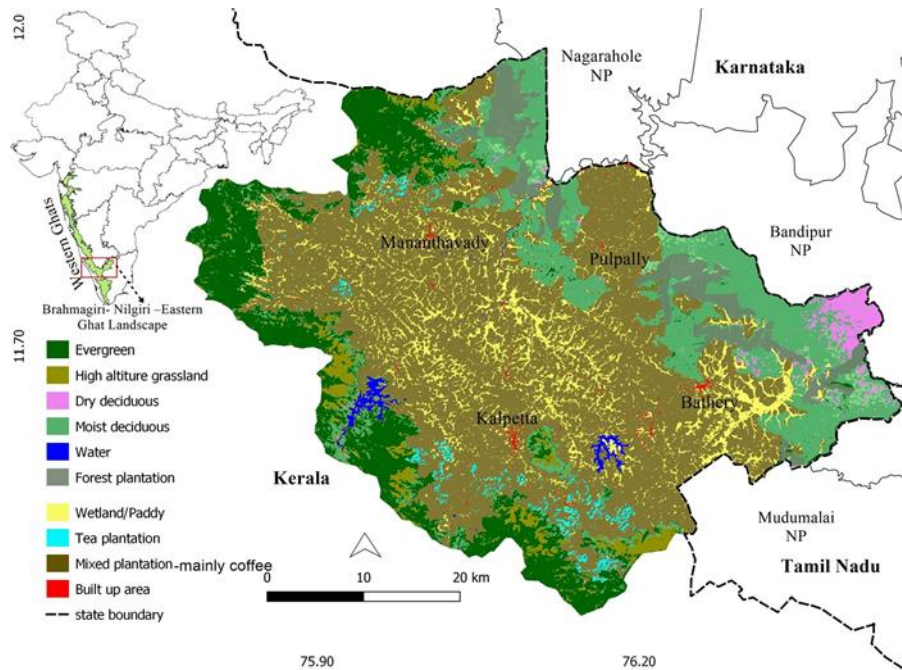
- Focus landscape: The Nilgiri-Wayanad-Chaliyar Corridor

Within this broader system, the project focuses on the Nilgiri-Wayanad-Chaliyar Corridor (NCC), a transboundary mountain-to-coast landscape that forms the core intervention area. The corridor connects the high-altitude montane zones of the Nilgiris and Wayanad with the midstream agro-ecological landscapes of Malappuram and the downstream estuarine and coastal systems of Kozhikode. It operationalizes a clear source-sink system, integrating upstream forested headwaters, midstream valleys, and downstream coastal sinks into a single, functionally connected socio-ecological landscape. Despite variation in elevation and landform, the districts within the NCC are bound together by shared river basins, continuous forest tracts, and strong hydrological connectivity. This interconnectedness means that ecological degradation or climate stress in upstream areas directly translates into increased flood, sedimentation, and water-security risks downstream. The landscape can be divided into three clear regions.

²⁴ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

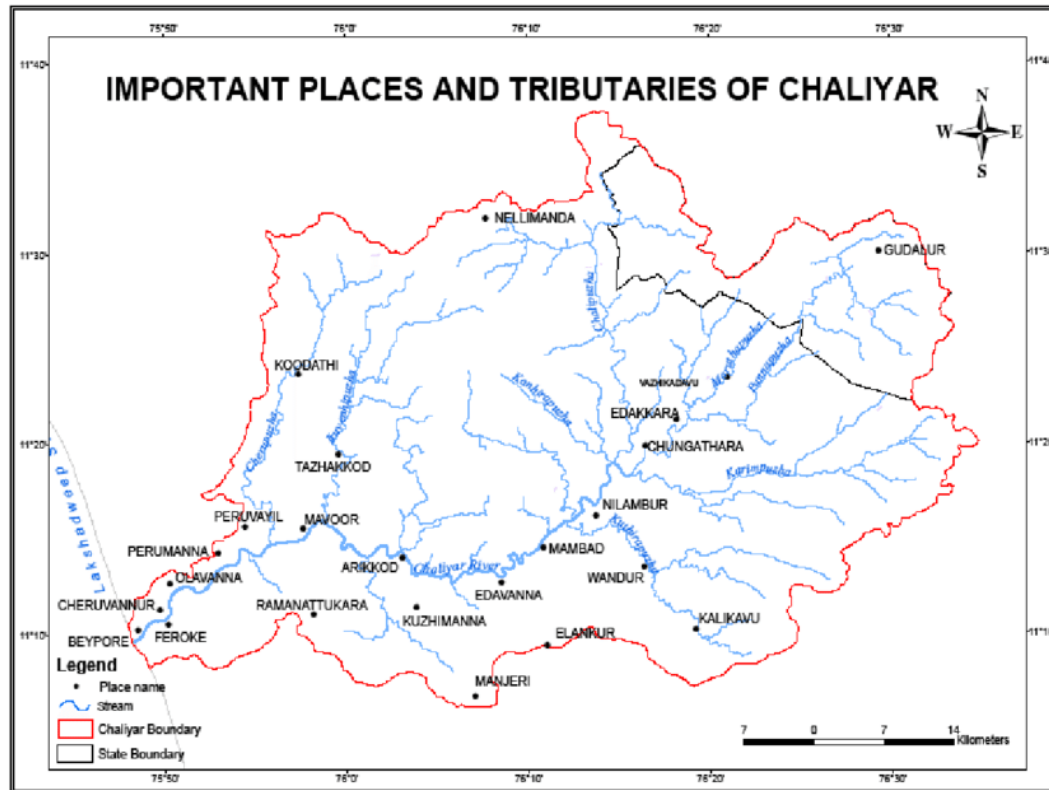
²⁵ Ibid

²⁶ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)



- Upper montane headwaters: Nilgiris and Wayanad

The Nilgiris (Tamil Nadu) and Wayanad (Kerala) together form a contiguous upper montane and plateau system at the southern edge of the Deccan Plateau. Elevations across this zone range from approximately 700 to 2,600 meters above sea level, and the terrain is defined by steep slopes, shallow soils, and complex drainage patterns. The dominant ecosystems include montane shola-grassland complexes, interspersed with forest patches and plantation landscapes. This upper montane zone functions as a critical hydrological source area, giving rise to the headwaters of major river systems such as the Bhavani, Moyar, Kabini, and tributaries of the Chaliyar. High monsoonal rainfall, averaging over 2,300 millimetres annually in Wayanad, supports dense vegetation cover but also increases exposure to slope instability. The combination of rugged terrain, high-intensity rainfall, and land-use change renders this zone particularly susceptible to landslides and soil erosion, with cascading impacts on downstream systems.



Source - Survey of India

- The Hydrological pine: The Chaliyar River Basin

The Chaliyar River forms the hydrological backbone of the Nilgiri-Chaliyar Corridor, physically integrating the upper montane forests with the coastal lowlands. Originating in the Ilambalari Hills of the Nilgiri Biosphere Reserve near the Wayanad border, the river flows westward for approximately 170 kilometres, traversing the midstream agro-industrial landscapes of Malappuram before draining into the Arabian Sea at the Kadalundi-Chaliyam-Beyepore estuarine complex in Kozhikode. The basin covers a total catchment area of 2,933 square kilometres, sustained by an ecologically vital network of tributaries, including the Cherupuzha, Iruvanjippuzha, Kanjirappuzha, and Karimpuzha. Together, these river systems regulate seasonal water flows, sediment transport, groundwater recharge, and ecological connectivity across the corridor.

- Midstream and downstream zones: Malappuram and Kozhikode

Downstream of the highlands, the landscape transitions into the undulating midlands of Malappuram, characterized by terraced hills, forested tracts, and intensively cultivated valleys. This zone plays a critical regulatory role, moderating runoff and sediment loads from upstream catchments. Further west, Kozhikode forms the terminal sink of the corridor, encompassing lateritic midlands, low-lying floodplains, and coastal and estuarine systems. These downstream areas absorb upstream flows but are increasingly exposed to flooding, sedimentation, urban inundation, and coastal erosion.

- **Biodiversity and ecosystem functions**

The Ghats are also a global biodiversity hotspot, hosting over 7,400 species of flowering plants (around 1,700 endemic), 139 mammal species, and 508 bird species, along with a rich diversity of reptiles, amphibians, and invertebrates. It supports 70% of Asia's elephants, the largest tiger population in a single locality, and endemic species such as the Nilgiri tahr and Lion-tailed macaque, with bird endemics like the Malabar grey hornbill and Nilgiri flycatcher²⁷. Key forest types include tropical wet evergreen forests, montane shola-grassland complexes, and other ecosystems. These ecosystems play a critical role in regulating microclimates, stabilizing slopes, enhancing groundwater recharge, and moderating downstream flood risks. The Nilgiri Mountains, at the tri-junction of Tamil Nadu, Kerala, and Karnataka, provide a critical ecological corridor linking the Eastern and Western Ghats, sustaining these species and maintaining landscape connectivity.

2.2 Environmental context²⁸

The Wayanad–Nilgiris highland corridor is a critical ecological linkage within the Western Ghats biodiversity hotspot, connecting the moist deciduous and evergreen forests of Wayanad with the montane shola-grassland and evergreen systems of the Nilgiris. The corridor's steep topography and elevation gradient create a heterogeneous mosaic of habitats—shola-grassland complexes, evergreen and moist deciduous forests, riparian systems, and mid-elevation agroforestry belts—which collectively sustain high biodiversity and underpin essential regulating services. Hydrologically, the landscape functions as a major headwater and recharge zone influencing flows to the Kabini, Moyar, Bhavani, and Chaliyar rivers, while contributing to soil stability, groundwater replenishment, and carbon storage (Nair et al., 2021; Subbarayan et al., 2021; Ravindranath et al., 2018).

Over the past several decades, the corridor has experienced extensive land-use transformation driven by historic deforestation, agricultural expansion, plantation development, settlement growth, and tourism-related infrastructure. In Wayanad, forest cover declined sharply between the 1950s and 1980s and later stabilised, but fragmentation, edge effects, and declining forest condition continue to erode ecosystem resilience (Nair et al., 1978; Anoop, 2023). In the Nilgiris, headline tree cover change since 2000 may appear modest, yet substantial conversion and degradation of grasslands and woody savannas indicate significant ecosystem change, with implications for open-habitat biodiversity and landscape permeability (Sri et al., 2021). Across both districts, the expansion of plantations (tea, coffee, teak, eucalyptus and other monocultures), built-up areas, road networks, and tourism hubs has increased patchiness and disrupted hydrological pathways and slope processes (Ravindranath et al., 2018; Nair et al., 2021).

²⁷ United Nations Environment Programme (UNEP). (2025). Building Climate Resilient Villages: Village Adaptation and Development Action Initiative – Adaptation Fund Concept Note.

²⁸ This section is based on a baseline assessment and all references can be provided on request.

Ecological integrity has declined despite partial stabilisation of overall forest extent. Connectivity constraints are acute in functional wildlife movement zones, including Wayanad's recognised elephant corridors (notably the Naikatty–Ponkuzhi–Mulehole linkage), where plantations, dense settlements, fencing, and linear infrastructure restrict movement and compress habitat. Comparable pressures in the Nilgiris further affect wide-ranging species and corridor functionality for elephants, tigers, leopards, dholes, Nilgiri tahr, and endemic avifauna (Menon et al., 2017; Anoop, 2023). Degradation is amplified by invasive species, with *Lantana camara* and *Senna spectabilis* increasingly dominating disturbed forest tracts and suppressing native regeneration; *Senna* is reported to have expanded from 14.6 km² (2013) to approximately 123 km² (2023), altering fuel loads and fire regimes and reinforcing degradation feedbacks (Menon, 2023). Additional disturbance legacies include the mass bamboo die-off (2008–2010), which reduced a key forage resource, with recovery constrained by fire, grazing, and invasive encroachment (Easa, 1999; Achu et al., 2021; Anoop & Ganesh, 2020).

Hydrological and soil stability conditions have been progressively weakened by land-cover conversion and terrain modification. Replacement of native forest and grassland systems with plantation monocultures and intensive agriculture reduces infiltration and soil water retention, increases surface runoff, and diminishes aquifer recharge—contributing to heightened flash flood risk during extreme rainfall and water scarcity during dry periods (Nair et al., 2021). Watershed evidence from the Nilgiris (including the Coonoor catchment) indicates higher sediment yield and reduced water-holding capacity where forest has been converted to agriculture (Subbarayan et al., 2021). These pressures are compounded by road cutting, slope modification, drainage obstruction, quarrying, and tourism-associated construction, which together increase landslide susceptibility and erosion—particularly on steep slopes and in plantation landscapes where slope stability is intrinsically lower (Sri et al., 2021). Severe monsoon-period landslides and slope failures recorded in locations such as Meppadi, Vythiri, Coonoor, and Kotagiri underscore the interaction between extreme rainfall and structurally vulnerable land use and infrastructure development (Sri et al., 2021). Socio-ecological pressures are closely coupled to these environmental changes. In Wayanad, agrarian transitions away from diverse food crops towards perennial commercial crops (notably coffee, pepper, areca, and coconut) have reduced agrobiodiversity and food security buffers, increased exposure to market and climate volatility, and intensified human–elephant interactions by expanding elephant-attractive crops across farm–forest interfaces (Varughese & Purushothaman, 2021; Anoop et al., 2023b). Human–wildlife conflict has been severe, with Wayanad reporting 41 human deaths due to elephants and seven due to tigers between 2013 and 2023; fencing, roads, and settlement expansion both restrict animal movement and elevate accidental encounter risks (Sengupta et al., 2020). In the Nilgiris, tourism-led land conversion and rapid urbanisation around Ooty and Coonoor have expanded built-up areas and infrastructure footprints, increasing waste loads, fire risk, and barrier effects; resort and homestay proliferation and associated fencing further constrict habitat and intersect movement routes (Tamil Nadu Tourism Master Plan, 2024).

Overall, the baseline condition of the Wayanad–Nilgiris highland corridor is best characterised as an ecologically significant but increasingly fragmented and functionally stressed landscape. The dominant trends—habitat subdivision, invasive-driven degradation, altered hydrology, and rising slope instability—are occurring alongside intensified human use and conflict risks. Maintaining and restoring ecological connectivity, improving forest and grassland condition (including invasive management), and reducing hydrological and geomorphic vulnerability are central to sustaining biodiversity, watershed services, and socio-ecological resilience in the corridor (Menon et al., 2017; Nair et al., 2021; Sri et al., 2021; Anoop, 2023).

2.3 Socio-economic context²⁹

The Nilgiri–Wayanad–Chaliyar Corridor forms a contiguous socio-ecological landscape along the southern Western Ghats, supporting an estimated 1.5–2 million people across this basin³⁰. This mountain-to-coast system integrates upstream tribal and plantation communities, midstream agrarian populations, and downstream coastal and estuarine livelihoods, functioning simultaneously as a climatic refuge, a biodiversity hotspot, and a critical watershed for southern India³¹. It integrates upstream tribal and plantation communities, midstream smallholder agrarian populations, and downstream urban, coastal, and fishing livelihoods, sustaining populations across Kerala, Tamil Nadu, and Karnataka.

Ecologically and agro-climatically, the region is highly heterogeneous. Humid to sub-humid tropical conditions prevail, with mean annual rainfall of approximately 2,000–3,000 mm delivered largely by the southwest monsoon (IMD, 2023). The landscape comprises montane forests, shola–grassland complexes, tea and coffee estates, homestead agroforestry, and mixed farming systems. These systems support the headwater catchments of the Kabini, Bhavani, Moyar, and Chaliyar rivers, underpinning downstream water security, soil stability, and ecosystem services. However, over recent decades, the expansion of monoculture plantations, particularly tea, coffee, pepper, eucalyptus, and teak, has replaced traditional mixed forests and diversified cropping systems. This transition has weakened slope stability, reduced soil fertility, and diminished watershed resilience, increasing exposure to climate extremes (Nair et al., 2021).

The corridor’s population is socially diverse and economically dependent on climate-sensitive natural resources, resulting in high livelihood vulnerability. Indigenous communities form a significant proportion of the upstream population, including the Toda, Kota, Badaga, Kattunayaka, Adiya, Paniya, and Cholanaiikka. These groups possess deep ecological knowledge but face persistent marginalisation due to insecure land tenure, declining access to forests, and limited integration into formal development systems. In the Kerala segment of the Nilgiri Biosphere Reserve, over 1.5 lakh tribal people in Wayanad and

²⁹ This section is based on further background analysis and references can be provided on request.

³⁰ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents

³¹ Parthasarathy, D., Nair, A., & Thomas, R. (2021): Compounding hazards: Floods, landslides, and social vulnerability in Kerala, India. Published in Climate and Disaster Policy Review

adjoining districts confront growing livelihood stress linked to delays in land rights recognition, declining agricultural viability, and erosion of forest-based subsistence systems³². Particularly Vulnerable Tribal Groups (PVTGs), such as the Cholanaikka and Kattunayaka, are increasingly dependent on public support mechanisms, reflecting deepening structural insecurity.

Agriculture remains the dominant livelihood across the highlands but is characterised by structural fragility. In Wayanad, smallholder farms average approximately 1.35 ha, with more than 70 percent of cultivation rainfed, making production highly sensitive to monsoon variability (Mathew et al., 2018). Major crops include coffee, pepper, banana, and rice, often grown within agroforestry systems. In the Nilgiris, large tea estates coexist with highly fragmented smallholdings supporting vegetables, floriculture, and horticulture on steep terrain (TNAU, 2022). Plantation crops provide substantial employment but create long-term dependencies, limited diversification options, and exposure to commodity price volatility. In nearby lowlands such as Palakkad and Erode, paddy, maize, and sorghum dominate, yet increasing water stress heightens agricultural risk. Across the corridor, insecure land tenure, informal tenancy arrangements, and small, fragmented holdings constrain access to credit, insurance, irrigation investments, and soil conservation measures.

Income and employment patterns reflect widespread precarity. Household incomes are generally low, fluctuating seasonally, and derived primarily from small-scale farming, plantation labor, casual wage work, tourism, and irregular forest-based activities. Vulnerability assessments indicate that many households earn between INR 15,000 and 75,000 annually, with approximately 87 percent of workers informally employed and lacking social security coverage (Odhong et al., 2019; Alamgir et al., 2021). Climate shocks—crop failures, landslides, floods, or prolonged dry spells—frequently push households into debt cycles, forcing asset liquidation and reducing resilience to subsequent shocks. While estate owners and commercial farmers have relatively better access to capital and markets, smallholders and wage laborers rely heavily on informal financial networks; formal insurance penetration remains low, particularly among rainfed farmers and small tea growers.

Education and human capital levels are modest relative to state averages, constraining adaptive capacity. Most smallholders and plantation workers possess only primary or middle-school education, with limited exposure to technical or vocational training. Literacy levels among tribal communities are estimated to be 15–20 percent lower than district averages, with particularly low attainment among women (Census of India, 2011³³; Tripathi & Mishra, 2017; Hasan & Kumar, 2019). This educational baseline restricts engagement with agricultural extension, climate information services, financial institutions, and alternative

³² Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

³³ Literacy levels among tribal communities estimated to be 15–20% lower than district averages, constraining access to technical training, climate information, and livelihood diversification opportunities.

livelihood pathways. Extension and skill-development programs reach only a fraction of remote hill settlements, limiting innovation uptake.

Demographic trends further weaken resilience. Youth out-migration from hill and plantation areas to urban centers such as Kozhikode, Coimbatore, and Mysuru is widespread, resulting in an aging and increasingly feminised rural workforce (Mendoza et al., 2014; Sripada, 2021). Women constitute a substantial share of agricultural and plantation labor but face wage disparities, heavy unpaid care burdens, limited asset ownership, and restricted participation in decision-making (Varughese & Purushothaman, 2021). Older adults and persons with disabilities are disproportionately affected during climate extremes due to mobility constraints and weak social support systems.

Human-wildlife conflict has emerged as a significant livelihood stressor, particularly in forest-adjacent and upstream areas. Habitat degradation, landscape fragmentation, and climate stress have increased wildlife incursions into farms and settlements, resulting in crop loss, property damage, and heightened insecurity, further destabilising already fragile incomes. Adaptive capacity across the corridor is also constrained by infrastructure and governance gaps. Irrigation coverage remains below 15 percent of the net sown area (Pandey et al., 2017). Hill settlements are frequently cut off during extreme rainfall due to landslides, while road networks, minor irrigation tanks, and check-dams suffer from inadequate maintenance. Administrative fragmentation between Kerala and Tamil Nadu complicates coordinated watershed management, forest governance, transport planning, and climate response strategies (Raj & Sofi, 2021; Ravindranath et al., 2018).

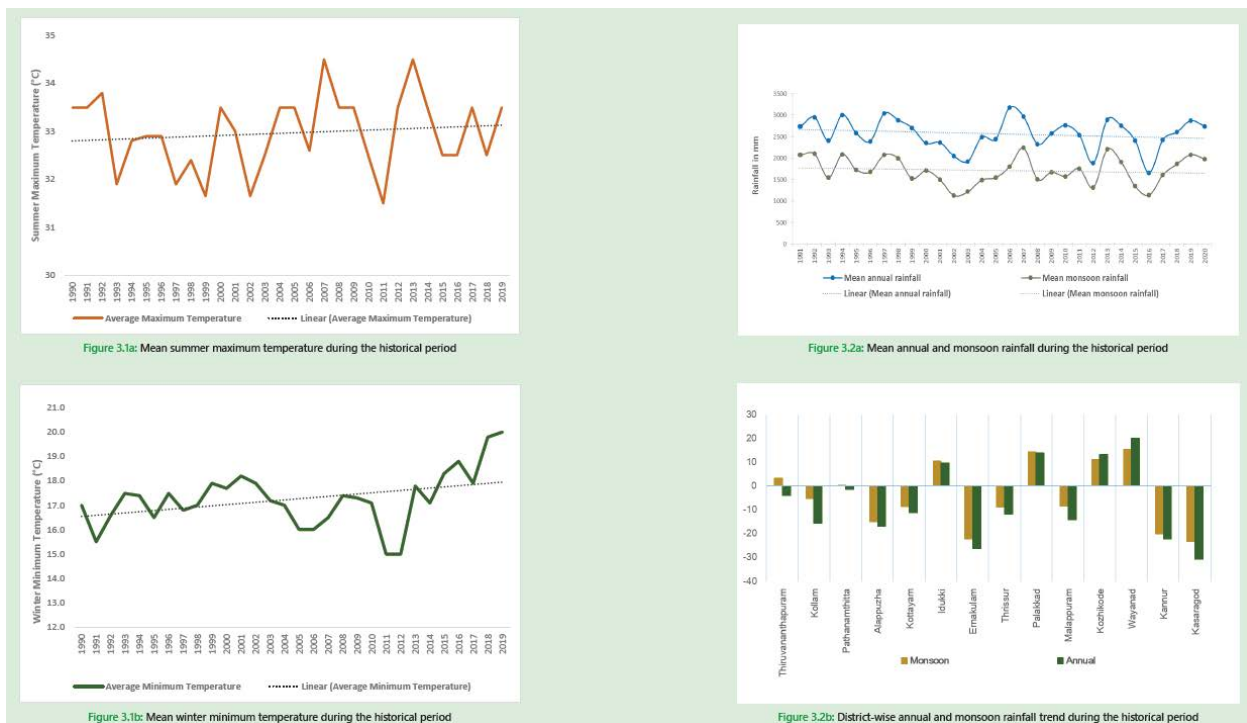
Overall, the Nilgiri-Wayanad-Chaliyar Corridor represents an ecologically fragile yet economically vital socio-ecological system where environmental degradation, socio-economic inequality, and climate variability are deeply intertwined. Heavy dependence on climate-sensitive livelihoods, combined with fragmented landholdings, low human capital, informal employment, and weak institutional coordination, places communities at the frontline of climate-induced vulnerability. Strengthening resilience will require integrated interventions that simultaneously address land-use sustainability, livelihood diversification, education and skills development, gender equity, financial inclusion, and cross-boundary institutional coordination.

Chapter 3: Historical climate trends and projections

3.1 Historical trends

The Western Ghats is experiencing increasingly visible impacts of climate change, in the form of rising temperatures, changing rainfall patterns, longer dry-spells, deforestation, soil erosion and landslides leading to biodiversity loss, forest fragmentation, agrarian stress and groundwater depletion. It has been noted³⁴ that the eastern parts of the Western Ghats had already begun noting higher temperature rises (2.2°C maximum and 1.7°C minimum), impacting crop yields. In contrast, the western slopes, encompassing much of Kerala, have experienced moderate warming, with summer maximum temperatures increasing between 0.31°C and 0.62°C, and winter minimum temperatures rising between 0.1°C and 0.32°C during 1990–2019 (**see figure 1 below**). The decade from 2012 to 2021 included eight of the ten warmest years on record, marking a period of significant anomalous warming³⁵.

Figure 1: Trends in temperature³⁶



Rainfall patterns across the Ghats have also shifted. While most of Kerala historically

³⁴ Kumar, S. N., Aggarwal, P. K., Rani, S., Jain, S., Saxena, R., & Chauhan, N. (2011). Impact of climate change on crop productivity in Western Ghats, coastal and northeastern regions of India. *Current Science*, 332-341.

³⁵ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

³⁶ Ibid

experienced a decreasing trend in mean annual rainfall, specific high-range districts such as Wayanad and Idukki have bucked this trend, exhibiting an increase in annual rainfall totals. Conversely, eastern leeward districts in Tamil Nadu have generally seen declines in rainfall, with some areas recording reductions of up to 20%³⁷. Alongside these shifts, the region is experiencing greater variability, characterized by prolonged dry spells, erratic monsoon onsets, and increasing frequency of high-intensity rainfall events.

The Wayanad–Nilgiri–Chaliyar corridor, spanning Kerala, Tamil Nadu, and Karnataka, presents a nuanced climatic pattern, deviating in several aspects from the broader Western Ghats. One notable phenomenon across the corridor is the accelerated warming of night-time minimum temperatures relative to day-time maximums, which has critical implications for montane ecosystems, crop physiology (coffee, spices, and horticulture), and hydrological cycles.

Wayanad, a high-altitude plateau ranging from 700 to 2,100 meters, demonstrates distinct historical trends reflecting both warming and increased rainfall intensity. While most districts in Kerala experienced declining rainfall trends, Wayanad has historically shown a consistent increase in mean annual rainfall. Analysis from 1979 to 2023 reveals a cumulative increase of 4.68 mm in extreme rainfall intensity, with a further increment of 1.06 mm during 2013–2023³⁸. High-intensity rainfall events in 2018, 2019, and 2021 saw daily anomalies reaching 14–22 mm, triggering floods and landslides. The district exhibits high variability, with 31% annually and 39% during the monsoon season, the highest among analyzed Kerala districts³⁹. Temperature trends indicate significant warming, with extreme maximum temperatures exceeding 35°C in multiple years (2014, 2016, 2017, 2019, 2020, and 2023). Minimum temperatures consistently exceeded 22.5°C over the past decade, with peaks nearly reaching 23.75°C, reflecting a narrowing diurnal temperature range. These thermal changes stress shade-dependent crops and forest ecosystems⁴⁰.

The Nilgiris, at elevations up to 2,600 meters, exhibit a cooler montane climate but are increasingly affected by warming night-time temperatures. Historical data (1985–2014) show a mean annual maximum temperature of 29.5°C, with a slight decrease of 0.1°C, while mean minimum temperatures increased to 19.4°C⁴¹. The district experienced an average of four heatwave days per year. Rainfall averaged 1,331.7 mm annually, with a significant increasing trend of 9.8 mm/year and about one day per year of intense rainfall exceeding 64.5 mm⁴². Together, these trends reveal rising thermal and hydrological stress in the Nilgiris.

³⁷ Ibid

³⁸ *Climate Change and Farmer Livelihoods in Wayanad, India: A Livelihood Vulnerability Index Assessment*, Nikhil Kumbrottil Sundaran, Aparna Radhakrishnan, Dileepkumar Ravindran, Binoo Palackal Bonny, and Navitha Vijayan Nandini.

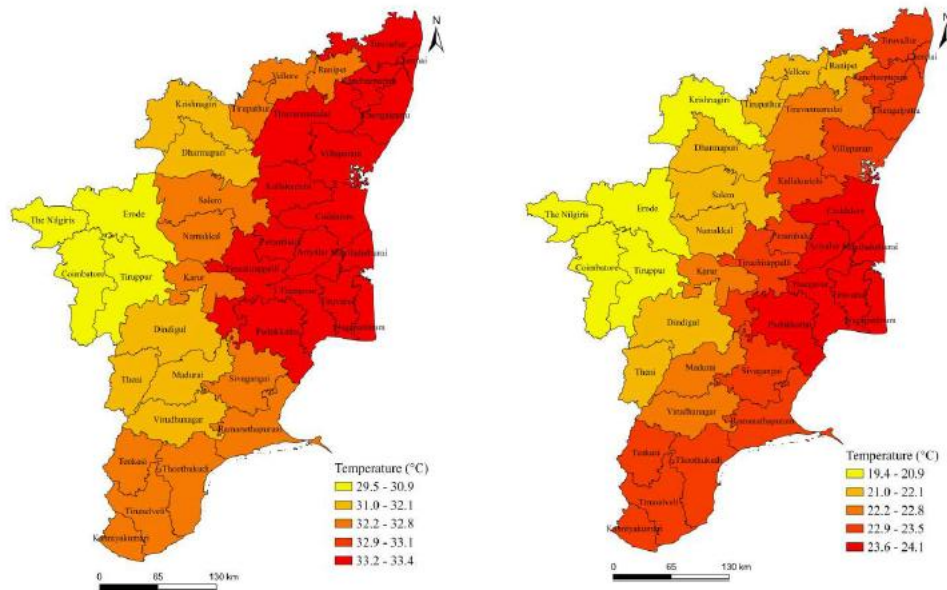
³⁹ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

⁴⁰ *Climate Change and Farmer Livelihoods in Wayanad, India: A Livelihood Vulnerability Index Assessment*, Nikhil Kumbrottil Sundaran, Aparna Radhakrishnan, Dileepkumar Ravindran, Binoo Palackal Bonny, and Navitha Vijayan Nandini.

⁴¹ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

⁴² Centre for Climate Change and Disaster Management, Dept of Civil Engineering Anna Univeristy (2024), Climate Profile and Projections of Tamil Nadu (Climate Modelling).

Figure 2: Spatial variation in observed annual min and max temperature in Tamil Nadu (1985-2014)



Despite increasing rainfall in Wayanad and Nilgiris, downstream areas experience water scarcity due to altered retention and runoff patterns. High-intensity rainfall leads to rapid downstream flow, causing flash floods in midlands (Malappuram) and lowlands (Kozhikode), while reducing soil moisture retention. For example, the Chaliyar river basin faces a freshwater deficit of 133.5 MCM during non-monsoon periods, projected to nearly double to 214 MCM by 2040⁴³. This wet drought scenario highlights the decoupling of rainfall volume from water availability, threatening irrigation and drinking water for over 1.5 million residents.

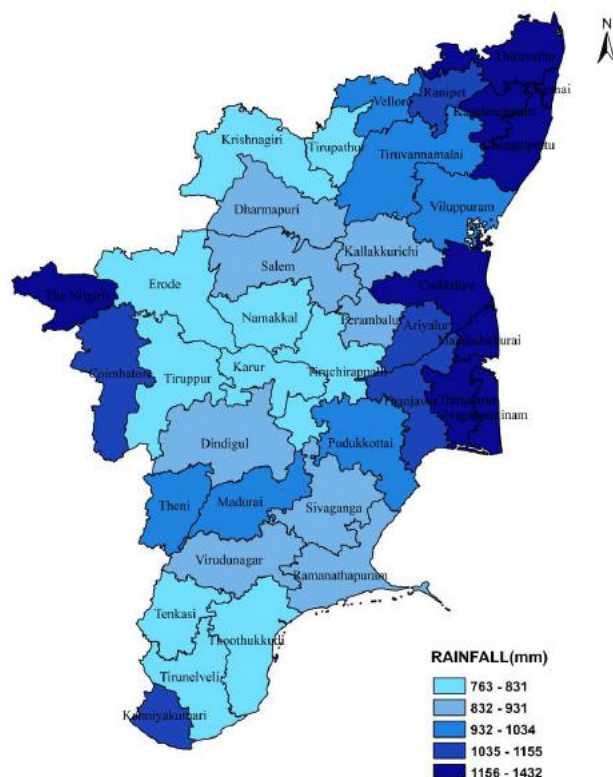
Further, historical climate shifts have also intensified ecological and livelihood vulnerabilities. Deforestation has been pronounced, with Wayanad losing 62% of its forest cover between 1950 and 2018⁴⁴. Coupled with extreme rainfall, this has destabilized steep slopes, as exemplified by the 2024 Chaliyar landslides. Moisture regime changes are projected to

⁴³ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁴⁴ United Nations Environment Programme (UNEP). (2025). Building Climate Resilient Villages: Village Adaptation and Development Action Initiative – Adaptation Fund Concept Note.

reduce wet evergreen and deciduous forest cover by 32% by 2050⁴⁵, with thorn forests replacing montane habitats. Agricultural losses from extreme floods (2019–2020) ranged between 20–50 % for crops such as coffee, pepper, and coconut, directly affecting smallholder economies linking mountain production to downstream markets.

Figure 3: Spatial observation in observed rainfall of Tamil Nadu (1985-2014)



In summary, the corridor has historically functioned as a sponge, absorbing steady monsoon rainfall in highlands and gradually releasing water to the plains. Current trends indicate that this sponge is shrinking due to deforestation, warming, and high-intensity rainfall. Rain now often results in destructive floods and landslides, followed by immediate post-monsoon droughts. Warming nights, increasing extreme rainfall events, and hydrological disruptions together create ecological, agricultural, and socio-economic vulnerabilities that require urgent adaptation and resilience strategies.

3.2 Projected future climate trends

⁴⁵ Climate Vulnerability Assessment and Adaptation Plan of Tamil Nadu, Forest Habitat Suitability, Climate Studio, Anna University, 2024- [csforest.pdf](#)

Climate projections for the Western Ghats indicate that the region is entering a phase of profound climatic and ecological transition. Historically regulated by predictable monsoon cycles and buffered by cool montane climates, the Western Ghats are projected to shift toward a regime defined by stochastic extremes, where higher annual rainfall coexists with acute water scarcity, and traditional biodiversity refuges face unprecedented heat stress. These changes are expected to intensify by mid-century and further accelerate toward the end of the century, with particularly severe implications for the Nilgiri-Wayanad-Chaliyar Corridor.

Across the Western Ghats, mean annual temperatures are projected to rise by approximately 1.5–2.0°C by 2050⁴⁶, fundamentally altering phenological cycles, ecosystem functioning, and water balances. This warming is expected to increase evapotranspiration rates and intensify heat stress across both forested and agricultural landscapes, reducing soil moisture retention and amplifying drought risk during non-monsoon periods. Rainfall projections indicate not a uniform decline, but a marked increase in variability. While total annual rainfall is projected to increase in many parts of the Ghats, the number of rainy days is expected to decrease in several mid-term scenarios, indicating a shift toward short-duration, high-intensity precipitation events rather than steady monsoon rainfall. This change is projected to heighten the risk of flash floods, landslides, and soil erosion, while simultaneously weakening groundwater recharge and base flows. Ecologically, these climatic shifts are projected to drive large-scale habitat transformation. In the Tamil Nadu segment of the Western Ghats, research suggests that evergreen and deciduous forest cover may decline by up to 32 % by 2050, with a corresponding expansion of thorn forest types driven by altered moisture regimes and rising temperatures. This transition represents a fundamental restructuring of forest composition, with implications for biodiversity conservation, carbon storage, and ecosystem services at a regional scale.

The Nilgiri-Wayanad-Chaliyar Corridor is projected to experience these broader climatic shifts in a particularly acute and interconnected manner. Functioning as a continuous mountain-to-coast system linking high-altitude headwaters, midstream agrarian zones, and coastal estuaries, the corridor is expected to face cascading impacts as climatic stress in the upper reaches propagates downstream. One of the most critical projected changes is the erosion of the thermal buffer that historically defined the high ranges. In the Nilgiris, annual average maximum temperatures are projected to increase by 1.8°C to 3.8°C by the end of the century, while minimum temperatures are projected to rise by 1.7°C to 3.9°C, indicating a strong warming of night-time conditions⁴⁷. This shift is expected to fundamentally alter montane shola-grassland ecosystems that depend on cool temperatures and occasional frost. Heatwaves, which historically averaged around four days per year in the Nilgiris, are

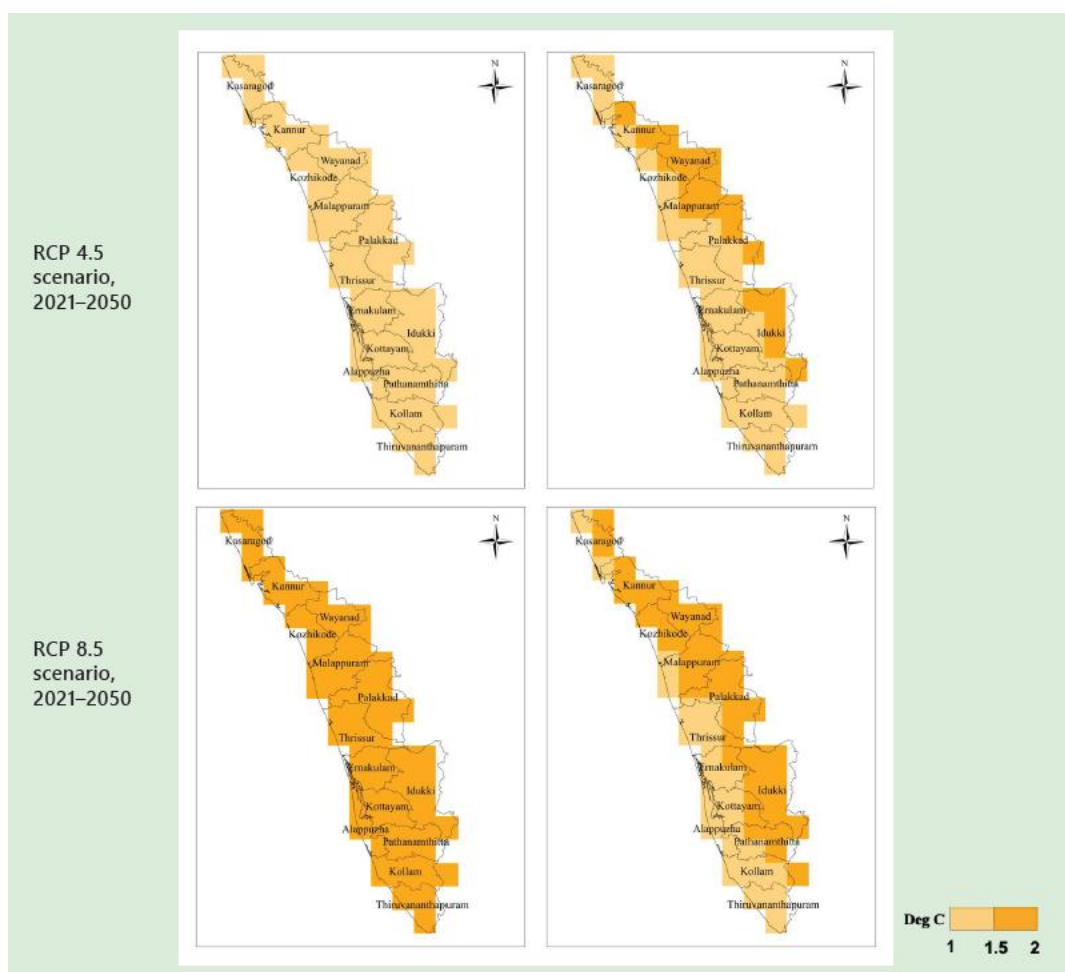
⁴⁶ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad-Coorg-Nilgiri region: Project background documents

⁴⁷ Centre for Climate Change and Disaster Management, Dept of Civil Engineering Anna Univeristy (2024), Climate Profile and Projections of Tamil Nadu (Climate Modelling).

projected to increase dramatically to approximately 55 days per year by the end of the century⁴⁸.

Wayanad is projected to experience a similar thermal shift. Winter minimum temperatures are expected to rise by 1°C to 2°C, further narrowing the diurnal temperature range and intensifying heat stress on both ecosystems and agriculture⁴⁹. Extreme maximum temperatures exceeding 35°C, once rare for this high-altitude plateau, are projected to become increasingly frequent, compounding stress on shade-grown coffee, spice systems, and forest vegetation.

Figure 5: Projected change in the summer maximum and winter minimum temperature (°C) during the near-term period under RCP 4.5 and RCP 8.5 scenarios. The changes are calculated by subtracting the mean over 1990–2019 from the mean over 2021–2050.

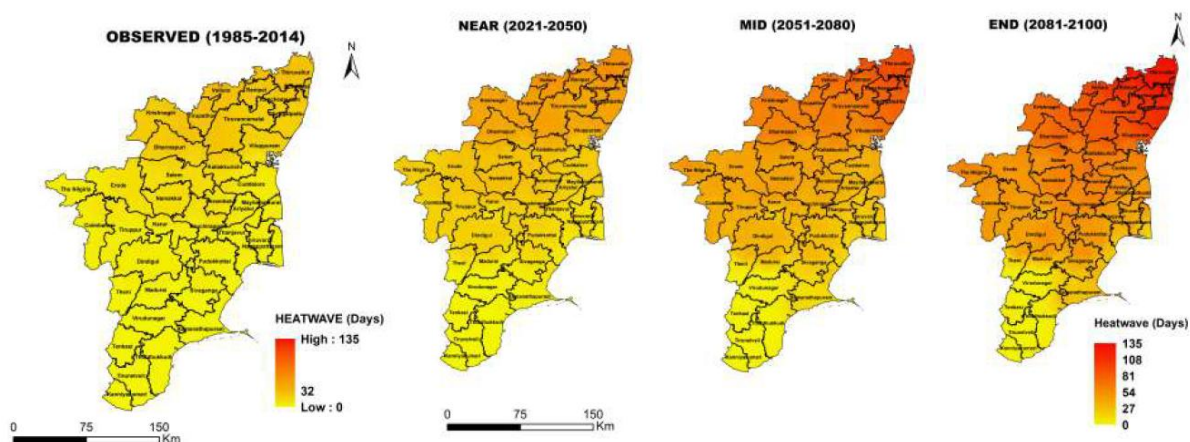


⁴⁸ Ibid

⁴⁹ Kerala State Action Plan on Climate Change 2023–2030, Department of Environment and Climate Change, Government of Kerala, 2022

Mid-low stream districts such as Coimbatore, Erode, and Malappuram are projected to face severe heat stress, with significant implications for water demand and labor productivity. Erode is projected to experience up to 49 heatwave days per year, while Coimbatore may experience approximately 47 heatwave days per year by the end of the century⁵⁰. In Malappuram, rising temperatures are expected to exacerbate evapotranspiration losses, accelerating river drying during non-monsoon months and intensifying water stress despite heavy monsoon rainfall.

Figure 6: Projected heatwave in Tamil Nadu under SSP2-4.5⁵¹



In summary, mean annual rainfall is projected to increase in districts such as Wayanad and Malappuram under both moderate and high-emission scenarios, while Coimbatore is projected to see rainfall increases of 26.7 to 32.6 %, and the Nilgiris 5.9 to 19.4 % by the end of the century⁵². However, this increase in volume is projected to be accompanied by a sharp rise in rainfall intensity. In Wayanad, very high-intensity rainfall events exceeding 100 mm per day are projected to increase by approximately three additional events per year under high-emission scenarios. Across Kerala districts, heavy rainfall days are projected to replace steady monsoon rainfall, significantly increasing runoff, slope instability, and flood risk. Despite higher rainfall, the Chaliyar River Basin is projected to face a freshwater deficit of 214 MCM by 2040 during non-monsoon periods due to rapid runoff and declining catchment retention capacity⁵³. These scenarios threaten drinking water security and irrigation for 1.5 to 2 million people dependent on the basin.

⁵⁰ Centre for Climate Change and Disaster Management, Dept of Civil Engineering Anna Univeristy (2024), Climate Profile and Projections of Tamil Nadu (Climate Modelling).

⁵¹ Shared Socioeconomic Pathways (SSPs) describe possible future societal and economic trends and, when combined with RCPs, help project climate impacts. SSP2-4.5 is a moderate, 'middle-of-the-road' scenario, while SSP5-8.5 assumes high emissions and fossil-fuel-driven growth [IPCC AR6, 2021].

⁵² Centre for Climate Change and Disaster Management, Dept of Civil Engineering Anna Univeristy (2024), Climate Profile and Projections of Tamil Nadu (Climate Modelling).

⁵³ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents

Figure 7: Projected average annual rainfall in Tamil Nadu under SSP2-4.5 AND SSP5-8.5⁵⁴

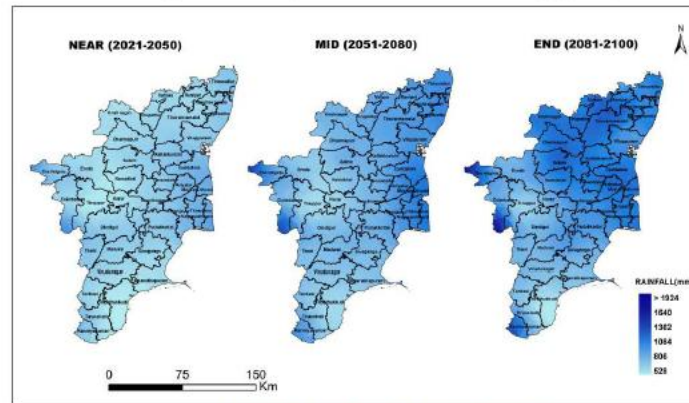


Figure 12 Projected Average Annual Rainfall under SSP2-4.5

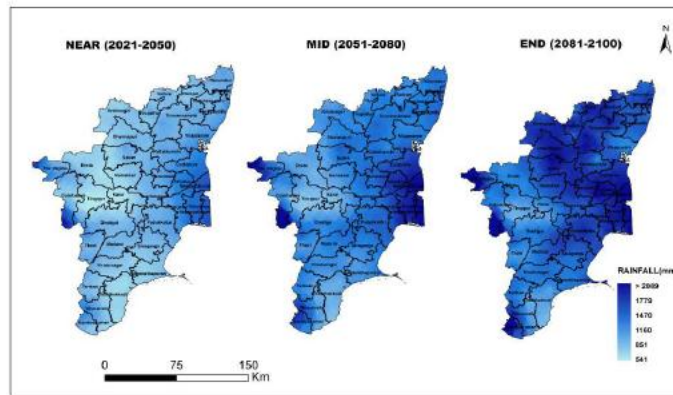
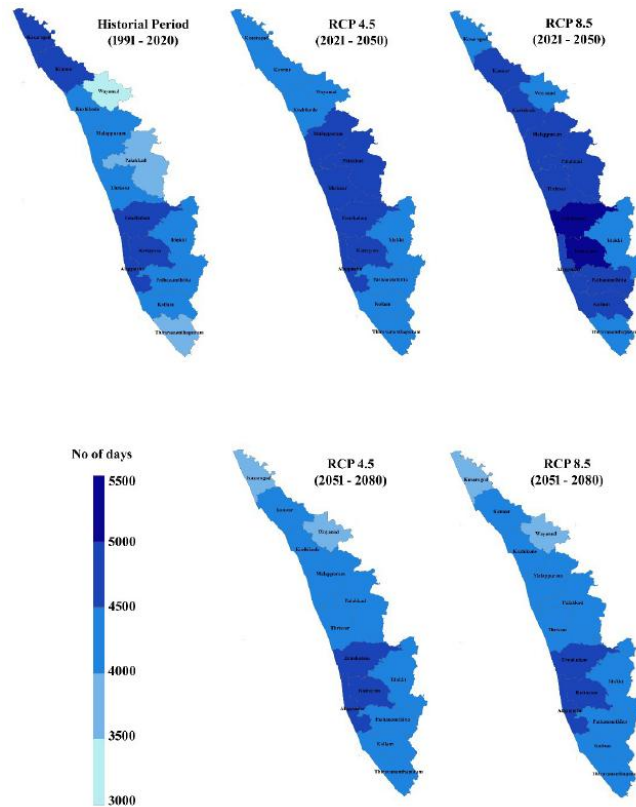


Figure 13 Projected Average Annual Rainfall under SSP5-8.5

Figure 8: Total number of rainy days during the historical (1991–2020) and projected near-term (2021-2050) and mid-term (2051-2080) periods under RCP 4.5 and RCP 8.5 scenarios for Kerala⁵⁵

⁵⁴ Shared Socioeconomic Pathways (SSPs) describe possible future societal and economic trends and, when combined with RCPs, help project climate impacts. SSP2-4.5 is a moderate, ‘middle-of-the-road’ scenario, while SSP5-8.5 assumes high emissions and fossil-fuel-driven growth [IPCC AR6, 2021].

⁵⁵ Representative Concentration Pathways (RCPs) are climate scenarios developed by the IPCC that describe possible futures of greenhouse gas concentrations and associated radiative forcing, with RCP 4.5 representing a moderate-emission pathway and RCP 8.5 representing a high-emission or ‘worst-case’ pathway [IPCC, 2014]



Projected climatic changes are also expected to trigger significant ecological reorganization across the corridor. In the Tamil Nadu Western Ghats, habitat suitability for evergreen forests is projected to decline by 17 %, and for deciduous forests by 11 %⁵⁶, while suitability for thorn forests is projected to increase by 60 % by 2050, indicating progressive aridification on the leeward side of the Ghats. In contrast, Wayanad and Palakkad are projected to experience limited changes in forest type, but increases in Net Primary Productivity driven by CO₂ fertilization may mask underlying ecological stress, including invasive species expansion and biodiversity loss. As forest interiors become hotter and drier, human-wildlife conflict is projected to intensify. Wildlife movement into agricultural landscapes and human settlements is expected to increase as animals search for water and forage, a trend already observed in Wayanad’s coffee and tea estates. These incursions are projected to exacerbate crop losses, livelihood insecurity, and social tensions across the corridor.

In the downstream coastal zones of Kozhikode and the Chaliyar estuary, projected climate impacts are expected to compound upstream stressors. Sea-level rise, combined with reduced summer river flows due to upstream water deficits, is projected to drive salinity intrusion inland, threatening coastal aquifers and drinking water supplies. Increased

⁵⁶ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

sediment loads and altered freshwater inflows are also expected to degrade estuarine ecosystems, fisheries, and coastal livelihoods, while intensifying urban flooding and coastal erosion risks.

Overall, projections indicate that the Nilgiri–Wayanad–Chaliyar Corridor is transitioning from a historically water-surplus, climatically buffered landscape into a high-volatility, water-deficit, hazard-prone system by 2040–2050. The corridor is projected to experience more intense floods and landslides during the monsoon, followed by acute water scarcity, heat stress, and ecological degradation in the dry season. This transformation threatens the resilience of montane forests, agrarian economies, and coastal systems alike, underscoring the urgent need for integrated, ecosystem-based adaptation and proactive landscape restoration across this transboundary socio-ecological system.

3.3 Climate Impacts

The projected climatic shifts in the Western Ghats are translating into tangible impacts on agriculture, water security, livelihoods, and ecosystems. The Nilgiri–Wayanad–Chaliyar Corridor, with its complex upstream–midstream–downstream connectivity, is already experiencing these impacts, which are expected to intensify over the next two to three decades and beyond as climate changes become more severe.

- **Agricultural yield**

Agricultural systems along the corridor are highly sensitive to fluctuations in temperature and rainfall. Smallholder farmers who cultivate coffee, tea, pepper, cardamom, and coconut have already suffered significant production losses, with 20–50 % of crops destroyed during events such as the 2019 Wayanad floods. Physiological stress due to sustained high temperatures has caused flower abortion in cardamom and reduced tiller growth, while shade-dependent crops like coffee and pepper have shown declining yields as minimum temperatures rise. In the Nilgiris, tea plantations, which rely on specific frost and mist patterns, are experiencing disrupted growth cycles that compromise both yield and quality. Looking forward, rising temperatures projected to increase by 1.5–2.0°C by 2050⁵⁷ are likely to alter flowering and fruiting cycles, rendering current crop varieties increasingly unsuitable. Tea plantations are expected to face up to 55 heatwave days per year by the end of the century⁵⁸, significantly reducing both quality and yield. Intensified rainfall extremes are projected to exacerbate waterlogging, soil erosion, and nutrient depletion, while pest and fungal outbreaks in crops such as coconut, coffee, and pepper may increase by 30–40 %.

⁵⁷ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁵⁸ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

Overall, the agro-climatic suitability for coffee and spice cultivation could shrink by 15–25 %, compelling farmers to adapt through crop diversification or relocation.

- **Water availability**

Water resources in the corridor are increasingly constrained despite heavy monsoon rainfall, due to rapid runoff and limited soil retention. The Chaliyar River Basin already faces a non-monsoon freshwater deficit of 133.5 MCM⁵⁹, and midstream areas such as Coimbatore and Palakkad are experiencing declining groundwater levels. Coastal aquifers are beginning to show signs of salinity intrusion, particularly during dry months when river flows are low. By the 2040s, the freshwater deficit in the Chaliyar basin is projected to rise to 214 MCM⁶⁰, threatening irrigation and drinking water supplies for over 1.5 million residents. Saltwater intrusion is expected to extend 1–3 kilometers inland, further reducing freshwater availability. Groundwater depletion in midstream areas is projected to worsen by 15–20 %⁶¹. These hydrological stresses are likely to increase competition for water among domestic, agricultural, and industrial users, exacerbating the corridor's vulnerability to both drought and flood events.

- **Impact on vulnerable populations**

Marginalized communities along the corridor are disproportionately affected by these climatic shifts. Tribal groups such as the Cholanaikka, Paniya, and Kattunayaka are losing access to forest-based livelihoods as forest degradation, invasive species proliferation, and altered rainfall patterns reduce the availability of non-timber forest products. These communities are increasingly reliant on government support for subsistence, with projected declines of over 50 % in forest-derived incomes.

Smallholder farmers, who make up the majority of landholders, face repeated crop failures that push them into debt traps and limit their capacity to adopt adaptive measures. Women shoulder additional labor burdens, spending an extra two to three hours daily fetching water and caring for livestock under conditions of water scarcity and heat stress. Children and the elderly are particularly vulnerable to heat-related illnesses, waterborne diseases, and displacement during extreme weather events. Collectively, these demographic impacts reinforce existing socio-economic inequities, heightening the corridor's overall vulnerability.

- **Ecosystem and biodiversity impact**

Ecosystems along the corridor are undergoing rapid transformation under climate pressure. In the Nilgiris, evergreen forests are projected to shrink by 17 % and deciduous forests by 11

⁵⁹ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents

⁶⁰ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁶¹ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

% by 2050, while thorn and scrub vegetation is expected to expand by 60 %, signaling a marked aridification of the landscape. Wayanad has already lost 62 % of its forest cover between 1950 and 2018, fragmenting habitats and disrupting wildlife corridors. Rising temperatures and reduced forest cover are pushing elephants, tigers, and wild boars into farmland and settlements, increasing human-wildlife conflict, which is projected to rise by 20–25 % over the next three decades. Riparian zones along the Chaliyar River are destabilized by erosion and sedimentation, intensifying flood risks downstream. Coastal and estuarine ecosystems face siltation, salinity intrusion, and habitat loss, threatening fisheries and local livelihoods. These ecological changes create feedback loops that reinforce socio-economic vulnerability, particularly among tribal and agrarian communities dependent on these resources.

4. Climate Vulnerability Analysis

Climate vulnerability in the Western Ghats emerges from the interaction of exposure to climate hazards, sensitivity of ecological and social systems, and adaptive capacity, following the IPCC framework. Within this framework, the Nilgiri–Wayanad–Chaliyar Corridor stands out as one of the most vulnerable mountain-to-coast systems in peninsular India due to the convergence of high physical exposure, fragile ecosystems, and constrained socio-economic capacity to adapt.

The Western Ghats, a global biodiversity hotspot and the principal water tower of southern India, is widely classified as an ecologically fragile region. As mentioned in the previous sections, the landscape is undergoing a transition from historically stable monsoon-driven dynamics to a regime characterized by climatic volatility and extremes. This transition has intensified vulnerability across both windward and leeward slopes, particularly where ecological degradation and human dependence on climate-sensitive livelihoods intersect. The Ghats' steep terrain, high rainfall concentration, and extensive land-use change amplify the impacts of climatic stressors, making the region structurally predisposed to landslides, floods, drought-like water scarcity, and ecosystem degradation. The vulnerability within the Nilgiri–Wayanad–Chaliyar Corridor is cumulative and cascading, as stresses originating in the montane source zones propagate downstream through hydrological, ecological, and economic linkages.

- **Exposure to climate hazards**

Exposure in the corridor is exceptionally high due to the concentration of multiple climate hazards across a narrow and interconnected landscape. The upper reaches of Wayanad and the Nilgiris are increasingly exposed to extreme rainfall events that trigger landslides and slope failures. The 2024 landslides along the Chaliyar basin starkly demonstrated the lethal consequences of this exposure for hill communities living on destabilized slopes. Thermal

exposure is also rising sharply. The Nilgiris, which historically recorded the lowest mean annual maximum temperatures in Tamil Nadu, is now experiencing a rapid increase in extreme weather events⁶², while Wayanad is increasingly subjected to extreme daytime heat combined with persistently warm nights⁶³. This dual exposure to hydrological and thermal extremes places unprecedented stress on both ecosystems and human settlements. Downstream, the coastal zone around Kozhikode is exposed to a different but connected set of hazards. Sea-level rise, salinity intrusion, and coastal erosion threaten estuarine ecosystems and freshwater availability precisely at the point where upstream hydrological stress has already reduced dry-season river flows. This spatial stacking of hazards across elevation gradients makes the corridor particularly vulnerable as a whole^{64 65}.

Future projections indicate that exposure will intensify significantly, amplifying ecological and socio-economic risks across the corridor. As mentioned in section 3.2 on future climate trends, the mean annual temperatures in the corridor are expected to rise by 1.5–2.0°C by 2050⁶⁶, with night-time temperatures increasing by up to 3.9°C in the Nilgiris and Wayanad, heightening heat stress for both ecosystems and human populations. Heatwave days in high-altitude areas may increase from 4–5 days per year to 47–55 days by the end of the century⁶⁷, while rainfall variability is projected to rise, with short-duration, high-intensity events increasing in frequency, escalating the risk of flash floods, landslides, and soil degradation downstream. The Chaliyar River basin may experience a freshwater deficit of 214 MCM during non-monsoon periods by 2040⁶⁸, intensifying water scarcity and threatening the livelihoods and well-being of 1.5–2 million residents⁶⁹, emphasizing the urgent need for targeted climate adaptation and resilience-building interventions.

- **Sensitivity of ecosystem and livelihoods**

Sensitive in the corridor is amplified by long-term ecological degradation and livelihood dependence on climate-sensitive systems. One of the most critical drivers of sensitivity is land-use change, particularly deforestation. Wayanad has lost approximately 62 % of its forest cover between 1950 and 2018, severely compromising slope stability, soil moisture retention, and the buffering capacity of the landscape. The ecological baseline of the Wayanad–Nilgiris corridor reflects a severe historical transition from high-resilience native forests to climate-sensitive monoculture landscapes, including tea, coffee, pepper, rubber,

⁶² Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

⁶³ Climate Change and Farmer Livelihoods in Wayanad, India: A Livelihood Vulnerability Index Assessment, Nikhil Kumbrottill Sundaran, Aparna Radhakrishnan, Dileepkumar Ravindran, Binoo Palackal Bonny, and Navitha Vijayan Nandini.

⁶⁴ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

⁶⁵ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

⁶⁶ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents

⁶⁷ Centre for Climate Change and Disaster Management, Dept of Civil Engineering Anna University (2024), Climate Profile and Projections of Tamil Nadu (Climate Modelling).

⁶⁸ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁶⁹ Ibid

teak, and eucalyptus plantations, which has fundamentally heightened the sensitivity of both ecosystems and human livelihoods. This transformation has weakened the landscape's hydrological sponge effect, reducing infiltration, increasing runoff velocity, and creating a wet-drought dynamic where monsoon floods are followed by acute water scarcity, with non-monsoon freshwater deficits projected to rise from 133.5 MCM to 214 MCM by 2040⁷⁰. Smallholder agriculture, dominated by coffee, tea, and pepper, is particularly vulnerable, with fragmented landholdings (average 1.35 ha in Wayanad)⁷¹ and over 70% rainfed cultivation mean that even minor climatic deviations can trigger substantial losses, as seen after the 2019 floods when more than 40 % of coffee farmers and nearly one-third of pepper growers experienced production losses ranging from 20 to 50%⁷². In the Nilgiris, tea plantations are sensitive to subtle changes in mist, temperature, and frost regimes, making them vulnerable to even small climatic deviations. Degraded forests have also facilitated the spread of invasive species such as *Lantana camara* and *Senna spectabilis*⁷³, and driven elephants, tigers, and wild boars into human settlements, heightening human-wildlife conflict. As a result, even moderate climatic shocks now translate into disproportionately large impacts, such as landslides during heavy rainfall and water scarcity shortly after the monsoon.

Future sensitivity is expected to increase under projected climate change. Rising night-time temperatures and intensified heatwaves will stress shade-grown crops, coffee plantations, and forest ecosystems. High-intensity rainfall events will disproportionately affect rainfed agriculture, with projected yield losses potentially exceeding current levels of 20–50%. Montane ecosystems, including shola-grasslands, will face contraction due to thermal stress and altered moisture regimes. Invasive species may expand, and biodiversity loss is likely to accelerate.

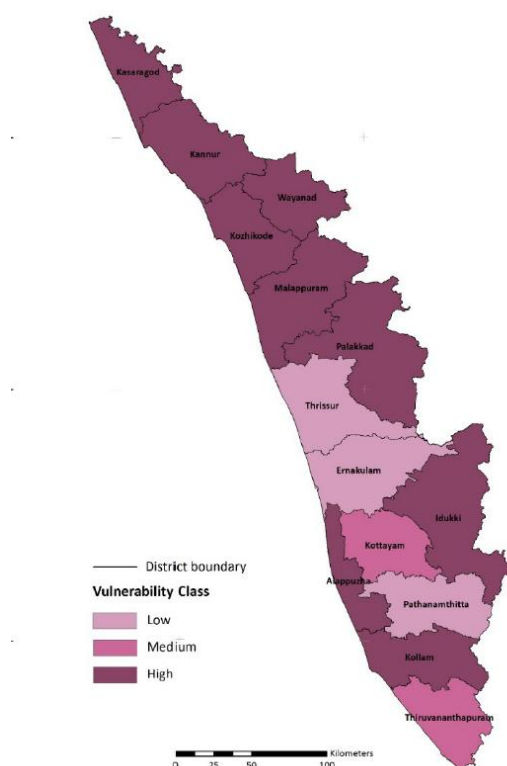
⁷⁰ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁷¹ Climate Change and Farmer Livelihoods in Wayanad, India: A Livelihood Vulnerability Index Assessment, Nikhil Kumbrottil Sundaran, Aparna Radhakrishnan, Dileepkumar Ravindran, Binoo Palackal Bonny, and Navitha Vijayan Nandini.

⁷² Ibid

⁷³ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents

Map of Kerala districts showcasing composite vulnerability⁷⁴



Social sensitivity further compounds ecological fragility. The region is home to highly vulnerable populations, including Particularly Vulnerable Tribal Groups (PVTGs) such as the Cholanaikka, Kattunayaka, Paniya, and Irula communities, whose livelihoods depend heavily on forest ecosystems, smallholder agriculture, and non-timber forest products. These communities face persistent vulnerabilities due to insecure land tenure, bureaucratic delays in land rights⁷⁵, and declining access to traditional forest resources. Literacy levels among tribal populations are estimated to be 15–20% lower than district averages, significantly limiting access to technical climate information, formal credit, and alternative livelihood training⁷⁶. The erosion of forest-based livelihoods, coupled with habitat degradation and invasive species, has led to a decline in forest-derived incomes for some PVTGs, particularly the Cholanaikka⁷⁷.

Vulnerability studies in Wayanad consistently show that households with elderly members above 65 years and children below five years are disproportionately affected during climate

⁷⁴ The composite vulnerability assessment identifies Wayanad, Kozhikode, Kasargod, Palakkad, Alappuzha, Idukki, Kannur, Malappuram, and Kollam as the most vulnerable districts in terms of overall inherent vulnerability

⁷⁵ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁷⁶ Census of India. (2011). Office of the Registrar General & Census Commissioner, India.

⁷⁷ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad–Coorg–Nilgiri region: Project background documents

shocks⁷⁸. These groups face mobility constraints, health risks, and limited access to emergency services, which amplify their sensitivity during floods, landslides, and heatwaves. Persons with disabilities also experience similar constraints, particularly during disasters such as the 2024 Wayanad landslides, when evacuation and access to relief services become extremely challenging.

Women represent a substantial proportion of the workforce, particularly in tea and coffee estates, and bear a disproportionate burden of climate-induced stress⁷⁹. Climate shocks increase unpaid care and domestic labor, forcing women to spend an additional hours daily fetching water and caring for livestock. Wage disparities, limited control over productive assets, and high reliance on manual labor (women account for 89.3% of person-days under MGNREGS in Kerala) further constrain women's adaptive capacity to recover from climatic shocks⁸⁰.

Future projections indicate that social sensitivity will intensify. Heat stress, water scarcity, and post-disaster recovery demands are likely to increase care burdens, particularly for women, children, and the elderly. Resource insecurity due to declining agricultural productivity and forest resource depletion may exacerbate livelihood precarity and human-wildlife conflict.

- **Adaptivity capacity**

Despite high exposure and sensitivity, adaptive capacity across the corridor remains low. Economic fragility is a central constraint. In Wayanad, a large proportion of farming households earn between Rs. 15,000 and Rs. 75,000 annually⁸¹, leaving little financial buffer to absorb climate losses or invest in adaptation measures such as irrigation infrastructure, crop diversification, or insurance. Access to formal credit and climate finance remains limited, particularly for smallholders and tribal communities. Institutional capacity, while relatively strong at the local governance level in Kerala, is weakened by the absence of effective transboundary coordination. Climate risks in the corridor do not respect administrative boundaries, yet planning and implementation remain fragmented across state jurisdictions. This limits the effectiveness of adaptation strategies that require basin-level or landscape-scale coordination, particularly for water management and ecosystem restoration. Infrastructure deficits further constrain adaptive capacity. Agriculture remains largely rainfed, irrigation coverage is limited, and water storage infrastructure is inadequate to buffer dry-season shortages. These limitations reduce the ability of communities to cope with both drought-like conditions and post-disaster recovery.

⁷⁸ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

⁷⁹ Government of Kerala, State Planning Board. (2025). Economic Review 2024 (Vol. One). Thiruvananthapuram, Kerala, India: Government of Kerala

⁸⁰ Government of Kerala, State Planning Board. (2025). Economic Review 2024 (Vol. One). Thiruvananthapuram, Kerala, India: Government of Kerala

⁸¹ Sundaran, N. K., Radhakrishnan, A., Ravindran, D., Bonny, B. P., & Nandini, N. V. (2024). *Climate change and farmer livelihoods in Wayanad, India: A livelihood vulnerability index assessment*

Future projections suggest that adaptive capacity challenges will intensify. Rising temperatures, increasing heatwave days (up to 55 per year in high-altitude areas), and intensified rainfall variability will heighten demand for irrigation, climate-resilient crop varieties, and emergency response systems. Limited financial resources, fragmented governance, and insufficient water storage infrastructure are projected to further constrain communities' ability to adapt to these stressors. Without proactive interventions, smallholder farmers, tribal communities, and marginalized groups will face growing difficulties in maintaining livelihoods, securing water, and sustaining agricultural productivity under future climate scenarios.

Vulnerability within the corridor is unevenly distributed. Smallholder farmers face high vulnerability due to their dependence on rainfed agriculture, exposure to climate shocks, and limited financial resilience. Tribal communities experience very high vulnerability as climate impacts intersect with insecure land tenure, declining forest resources, and systemic marginalization. Women face heightened vulnerability due to unequal access to resources, increased care burdens during climate disasters, and livelihood precarity. Elderly populations are particularly sensitive to heat stress and face increased risks during evacuation and disaster response.

Sectorally, rainfed agriculture faces critical risk as rising temperatures, intense rainfall, and disease outbreaks threaten crop productivity and farmer incomes. Future projections indicate that yield losses in key crops such as coffee, pepper, and tea could exceed current observed losses of 20–50% due to combined thermal and hydrological stress. Coastal fisheries in the Beypore–Kozhikode estuarine zone are likely to experience greater salinity intrusion and declining fish stocks, while water supply systems across the basin may face intensified non-monsoon shortages despite heavy monsoon rainfall.

Ecosystem vulnerability is most acute in montane shola forests, which are highly sensitive to warming and invasive species and are projected to shrink significantly in the coming decades. Riverine and riparian ecosystems along the Chaliyar are increasingly destabilized by erosion, deforestation, and altered flow regimes, while wetlands and estuaries in the coastal sink zone are threatened by siltation and salinity intrusion. Projected climate changes, particularly rising temperatures, altered rainfall patterns, and increasing extreme events, will amplify these ecological stresses, reducing the resilience of both natural systems and human communities that depend on them.

4.1 District-level vulnerabilities

District	Degree of vulnerability
Wayanad (Kerala)	Wayanad is highly vulnerable due to its dependence on coffee and black pepper cultivation, where floods and erratic rainfall can cause yield losses of 20–50%. Nearly 70% of agricultural land is rainfed, which

	increases sensitivity to rainfall variability and drought. The district has a large tribal population with lower literacy levels and high reliance on public support, limiting adaptive capacity. Forest fragmentation, soil erosion, and pressure on elephant corridors exacerbate ecological and livelihood risks.
Kozhikode (Kerala)	Kozhikode faces high vulnerability because of dense population settlements in low-lying coastal areas, which increases sensitivity to flooding and sea-level rise. Poor irrigation coverage and limited groundwater availability constrain the ability of local communities to cope with water stress. Artisanal fisheries are sensitive to marine and coastal changes, while forest and wetland degradation add pressure to ecosystems and livelihoods.
Malappuram (Kerala)	Malappuram is highly sensitive due to a large population of infants, elderly, and people with disabilities, making the health sector particularly vulnerable. Coastal erosion, flooding in low-lying valleys, limited groundwater availability, and a high prevalence of communicable diseases further reduce the adaptive capacity of communities. Livelihoods dependent on agriculture and fisheries face increasing risks under climate variability.
Nilgiris (Tamil Nadu)	The Nilgiris is highly vulnerable because of its steep terrain and dependence on tea and vegetable cultivation. Fragmented landholdings and tourism-driven land conversion increase slope instability and ecosystem degradation. Montane species such as the Nilgiri tahr are losing habitat due to warming temperatures and forest fragmentation, which adds to ecological sensitivity.
Coimbatore (Tamil Nadu)	Coimbatore is sensitive to urban heat stress, pollution, and moderate thermal discomfort, with industrial and residential areas highly affected by heat-island effects. Limited green cover and water storage reduce resilience to rising temperatures and water stress. Agricultural areas face moderate vulnerability due to temperature and rainfall variability, which affects crop performance.

4.2 Gendered and marginalized group vulnerabilities

Both the Kerala State Action Plan on Climate Change and the Tamil Nadu State Action Plan on Climate Change recognize that climate change disproportionately affects women and marginalized groups, including children, older persons, persons with disabilities, socially excluded communities, and economically disadvantaged populations.

Both plans acknowledge that existing structural inequalities related to gender, socio-economic status, access to resources and finance, land ownership, health, education,

mobility, and participation in decision-making increase vulnerability to climate risks and can limit adaptive capacity. Tamil Nadu's plan further expands the analysis by highlighting the specific ways climate change affects women and marginalized populations. It identifies heightened vulnerabilities related to maternal health during extreme heat events, increased exposure to climate-sensitive diseases, heightened risks of gender-based violence following climate disasters, and the disproportionate burden of unpaid care work, particularly during water shortages.

The two state-level action plans adopt a broadly similar approach centered on gender-responsive and inclusive climate action, emphasizing that the priorities and needs of vulnerable and marginalized groups should be integrated into climate planning, financing, and implementation processes. They promote greater participation of women in local decision-making on climate-related investments and resource allocation, strengthen women-led community organizations such as self-help groups and neighbourhood networks, and support inclusive investments in adaptation, mitigation, technology transfer, and capacity-building initiatives.

Both plans also emphasize the need to enhance climate resilience among women through livelihood-focused interventions and improved access to essential services. This includes strengthening access to healthcare and climate-related emergency services, particularly for women, children, persons with disabilities, the elderly, and other vulnerable groups. In addition, both action plans commit to incorporating gender-sensitive indicators and benchmarks into monitoring and evaluation systems to track the effectiveness and inclusiveness of climate interventions.

Tamil Nadu state action plan on climate change frames women not only as vulnerable groups but also as agents of climate action, recognizing their role in agriculture, natural resource management, and community resilience. The plan advocates for gender-responsive agricultural extension services, improved access to climate-smart technologies and financial services, promotion of green skills and employment opportunities, strengthened social protection systems, and targeted efforts to increase women's representation and voice in climate governance. It also calls for a systematic gender lens to be applied across all climate interventions and for implementing agencies to develop gender-responsive actions and outcomes.

The initial stakeholder consultations for concept note preparation in January and February 2023 (see stakeholder consultation report) also showed that women in the target districts of Kerala and Tamil Nadu, particularly from indigenous and smallholder households, face multidimensional vulnerabilities from economic marginalization, social barriers, and environmental stress. They bear primary responsibility for domestic water collection, often traveling 2–3 km daily; during dry spells, this can extend by 2–3 hours, contributing to physical strain and “time poverty,” reducing rest and income opportunities (Stakeholder consultations, 2026). Girls are often pulled into water collection, leading to interrupted

schooling and limiting future adaptive capacity. Women also manage household care during health crises, including waterborne diseases and heat-related illness, compounding unpaid labor burdens (Stakeholder consultations, 2026). Women lack ownership of productive assets such as land, limiting access to credit, crop insurance, and compensation for wildlife-related crop damage (Stakeholder consultations, 2026). They play a central role in cultivating subsistence crops, particularly millets, managing seed selection, cultivation, and storage; declining yields threaten household food security, especially in female-headed households. Limited access to training and agricultural extension, and limited participation in local governance and decision-making within households and communities reduce adaptive capacity and compound vulnerability to climatic and ecological shocks.

Stakeholder consultations reinforced that interventions must prioritize women, marginalized farmers, and indigenous groups households to address these systemic inequalities and strengthen community resilience (Government of Kerala, State Planning Board, 2025; Stakeholder consultations, 2025).

Chapter 6: Alignment with national climate policies and sustainable development goals

The strategic roadmap for Wayanad, Kozhikode, Malappuram, Nilgiris, and Coimbatore is anchored in India's National Action Plan on Climate Change (NAPCC), which provides the overarching framework for climate resilience. The National Mission for Sustainable Agriculture (NMSA) is critical for the highlands of Wayanad and Nilgiris, prioritizing soil and water conservation, climate-resilient crop varieties, and agroecological practices to safeguard coffee, tea, and spice production. The National Mission on Sustainable Habitat (NMSH) guides urban resilience in industrial hubs like Coimbatore and coastal districts like Kozhikode, focusing on energy efficiency, waste management, and the Climate Smart Cities Assessment Framework. The Green India Mission (GIM) targets forest restoration in the Western Ghats, enhancing carbon sinks and ecosystem services in Nilgiris and Wayanad. Both Kerala and Tamil Nadu have aligned their state plans with India's Nationally Determined Contributions (NDCs) under the Paris Agreement, aiming to reduce emissions intensity and create additional carbon sinks. Alignment with the Sendai Framework for Disaster Risk Reduction has shifted district-level strategies from reactive relief to proactive risk reduction, particularly for landslide mitigation in Wayanad and Nilgiris and flood management in Kozhikode.

State-specific initiatives translate these national mandates into context-specific actions. In Kerala, the SAPCC 2.0 (2023–2030)⁸² identifies Wayanad, Kozhikode, and Malappuram as

⁸² Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

high-priority zones for ecosystem-based adaptation and decentralized planning. Post-2018 flood interventions under the Rebuild Kerala Initiative (RKI) emphasize risk-informed land use and river basin management for the Chaliyar and Kabini systems, integrating adaptation measures into local development plans. Wayanad's designation as an Aspirational District under NITI Aayog allows resilience strategies to address gaps in tribal health, education, and infrastructure while embedding climate adaptation. The Carbon Neutral Meenangadi pilot demonstrates scalable, community-led approaches to carbon neutrality through tree banking, renewable energy adoption, and waste management. In Tamil Nadu, the Climate Change Mission prioritizes the Nilgiris as an ecologically fragile hotspot, focusing on the conservation of shola-grassland ecosystems and native vegetation restoration. District-level climate action is strengthened through District Climate Change Action Plans (DCCAPs) and initiatives under the Green Tamil Nadu Mission, supported by high-resolution climate data from institutions such as Climate Studio (Anna University) to inform agriculture and water resource planning in Erode and Coimbatore.

The corridor faces systemic vulnerabilities due to high dependence on rainfed agriculture, climate-sensitive crops, fragmented governance, limited irrigation coverage, and rising human-wildlife conflicts caused by forest fragmentation and land-use change. These factors necessitate integrated strategies that combine ecosystem restoration, climate-smart agriculture, and community-led governance to enhance resilience.

The corridor's adaptation interventions are explicitly aligned with India's NAPCC and NDCs. Under the National Mission for Sustainable Agriculture⁸³, VADAI promotes climate-resilient practices such as shade-grown coffee agroforestry and millet/tuber cultivation in Wayanad and Nilgiris, enhancing smallholder food security under erratic climatic conditions. Through the Green India Mission⁸⁴, the initiative restores approximately 8,000 hectares of degraded land and establishes biodiversity corridors in the Nilgiri-Wayanad landscape, connecting fragmented habitats and protecting over 100 Other Effective Area-Based Conservation Measures (OECMs), including sacred groves and wetlands. Water security objectives under the National Water Mission⁸⁵ are addressed through source-sink synergies in the Chaliyar River Basin, including community-led water budgeting and riverbank stabilization, targeting projected freshwater deficits of 214 MCM by 2040. At the NDC level, the corridor contributes to India's climate commitments by creating carbon sinks through forest restoration and agroforestry, operationalizing adaptation in agriculture and water resources, and promoting sustainable lifestyles under the Mission LiFE framework through circular economy pilots and community-led carbon neutrality initiatives.

⁸³ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

⁸⁴ Ibid

⁸⁵ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad-Coorg-Nilgiri region: Project background documents

Adaptation actions are also mapped to the United Nations Sustainable Development Goals (SDGs). Climate risk assessments and institutional capacity building support SDG 13 (Climate Action) across local Panchayat Development Plans. Habitat restoration, human-wildlife conflict management, and protection of shola-grassland ecosystems advance SDG 15 (Life on Land). Water security interventions under community-led watershed programs address SDG 6 (Clean Water and Sanitation), while NMSA-aligned initiatives targeting food production for smallholders and tribal communities contribute to SDG 2 (Zero Hunger) and SDG 1 (No Poverty). Gender equity is reinforced under SDG 5 (Gender Equality), with women's participation in governance and training platforms set at 50%, empowering women-led self-help groups in climate resilience planning.

Finally, the project proposal aligns with state and central schemes for scalability and financial sustainability. It operationalizes Kerala's SAPCC 2.0 and Tamil Nadu's Climate Change Mission, integrates climate-resilient works into MGNREGS, and targets resilience strategies in Wayanad under the Aspirational Districts Programme, thereby linking local adaptation with national development priorities.

Chapter 7: Problem Statement

7.1 Core Problem Statement

"The Western Ghats is experiencing a critical decline in ecosystem integrity and resilience, driven by the combined impacts of climate change, historical landscape transformation, and socio-economic vulnerability. This has disrupted hydrological systems, degraded habitats, intensified human-wildlife conflicts, and undermined the adaptive capacity of local and indigenous communities, threatening biodiversity, livelihoods, and long-term water and food security across the region."

The Western Ghats is a globally significant ecological landscape, providing critical ecosystem services that sustain regional hydrology, regulate climate, and maintain biodiversity. Forested watersheds within the Ghats capture monsoon rainfall, recharge aquifers, and sustain perennial rivers, forming the backbone of local agriculture, domestic water supply, and energy production. These ecosystems also harbor numerous endemic and endangered species, including the Nilgiri tahr, Lion-tailed macaque, and diverse amphibians, while supporting complex wildlife corridors essential for elephants, tigers, and other megafauna. The degradation of forest cover, habitat fragmentation, and loss of native vegetation have weakened these ecological functions, undermining the Ghats ability to buffer against climate extremes and maintain ecological connectivity.

Climate change is compounding historical pressures, altering temperature and rainfall patterns, and increasing the frequency and intensity of extreme weather events such as heatwaves, intense rainfall, floods, and droughts. These climatic shifts disrupt the phenology and productivity of native species, exacerbate soil erosion, destabilize slopes, and strain water resources. Recent scientific assessments indicate that the region has experienced a five-fold increase in extreme weather events over the last five decades. Mean annual temperatures in the Western Ghats are projected to rise by 1.5–2.0°C by 2050⁸⁶, which will fundamentally restructure forest composition and alter the phenology of endemic species such as the Nilgiri tahr (*Nilgiritragus hylocrius*) and Lion-tailed macaque (*Macaca silenus*). Compounding this warming is severe deforestation: Wayanad alone lost 62% of its forest cover between 1950 and 2018⁸⁷, dramatically reducing the landscape's natural sponge effect, i.e. its ability to absorb monsoon rainfall and release it gradually to downstream communities.

The combined effects of climate change and deforestation have resulted in a decoupling of rainfall volume from water availability. While total annual rainfall may increase in some areas, the number of rainy days has decreased, replaced by high-intensity precipitation events that trigger catastrophic landslides and flash floods. For example, the 2024 Wayanad disaster highlighted the lethal consequences of these shifts. During non-monsoon periods, the Nilgiri Biosphere Reserve–Chaliyar River Basin corridor, which underpins the corridor's hydrology, faces a freshwater deficit of 133.5 MCM, projected to rise to 214 MCM by 2040⁸⁸. Without immediate intervention, the region of Tamil Nadu's Western Ghats faces cascading environmental failures, including a projected 32% decline in evergreen and deciduous forest cover by 2050 and the permanent loss of critical ecosystem services that support over 1.5 million people.

The NCC corridor plays a critical role in maintaining regional biodiversity and ecological connectivity. Forest in the corridor provide a habitat for elephants, tigers, endemic amphibians, and over 250 plant species, while supporting the livelihoods of local communities, particularly indigenous groups like the Cholanaikka and Kattunayaka, who depend on these forests for food, medicinal plants, and cultural practices. The degradation of these ecosystems threatens not only biodiversity but also livelihood security, water availability, and long-term agricultural productivity.

Socio-economic vulnerability among communities living along the corridor amplifies the landscape's exposure to environmental shocks. Heavy dependence on land-based livelihoods, limited livelihood diversification, and recurrent human–wildlife conflict reduce households' capacity to absorb disturbances such as climatic extremes, invasive species

⁸⁶ Environment Department, Government of Kerala. (2025). Advancing Adaptation & Development Action through Source-Sink Synergies for Climate Resilience in the Villages of NBR–Chaliyar River Basin (Concept Note Proposal for UNEP Adaptation Fund).

⁸⁷ United Nations Environment Programme (UNEP). (2025). Building Climate Resilient Villages: Village Adaptation and Development Action Initiative – Adaptation Fund Concept Note.

⁸⁸ Ibid

spread, and crop loss. These pressures often trigger coping responses, including land-use intensification, fencing, or further habitat conversion, creating a feedback loop in which social vulnerability and ecological fragmentation reinforce one another. The majority of local households are engaged in informal employment and earn low incomes, with agriculture dominated by rainfed monocultures such as tea, coffee, pepper, and eucalyptus. This reliance on climate-sensitive livelihoods leaves communities highly susceptible to crop failure, landslides, and floods. Indigenous and tribal groups, including Particularly Vulnerable Tribal Groups like the Cholanaikka and Kattunayaka, face additional marginalization due to insecure land tenure, restricted access to forest resources, and limited participation in formal governance. Labor precarity, youth out-migration, and gendered burdens of care further reduce the adaptive capacity of these communities, reinforcing cycles of vulnerability.

Governance and policy gaps exacerbate these challenges. The corridor spans Kerala and Tamil Nadu, yet transboundary coordination for integrated forest management, water governance, and climate adaptation is limited. Weak enforcement of environmental regulations, fragmented spatial planning, and prioritization of short-term economic development over ecosystem sustainability have facilitated unsustainable land-use practices such as steep slope road construction, quarrying, and large-scale monoculture plantations. These systemic governance limitations compound ecological degradation, reduce natural capital, and hinder the implementation of coordinated adaptation strategies across the corridor.

In combination, these ecological, climatic, and socio-economic pressures constitute a complex adaptation challenge. Without urgent, integrated interventions that restore ecosystem function, strengthen governance, and enhance the adaptive capacity of vulnerable communities, the NCC faces escalating biodiversity loss, declining water security, and deepening livelihood vulnerabilities. Addressing this core problem requires a holistic, landscape-based approach that simultaneously safeguards ecological integrity, enhances climate resilience, and supports socio-economic development for the corridor's inhabitants.

The table below captures the key environmental threats in the Western Ghats, their underlying root causes, and the systemic barriers that limit effective conservation and climate adaptation.

Direct Threats	Indirect Threats	Root Causes	Barrier Analysis
- Climate change–driven thermal stress and altered rainfall regimes - Habitat degradation,	- Unsustainable agricultural practices and monoculture expansion - Constrained adaptive	Economic growth and unsustainable consumption patterns	Lack of landscape approach and weak institutional support systems

conversion, and fragmentation • Ecosystem restructuring, biological invasions, and rising human–wildlife conflict • Hydrological stress and emergence of wet-drought conditions • Soil erosion and climate-amplified landslides • Bushfires (forest fires) • Downstream estuarine and coastal degradation	capacity of smallholder farmers • Limited public and private finance for support to climate smart practices • Limited access to agricultural insurance and risk transfer mechanisms • Weak governance, policy gaps, and administrative fragmentation • Education and technical knowledge gaps, limited capacity for adaptation • Chronic underinvestment in infrastructure, services, and adaptive capacity • Weak agricultural extension and climate advisory services	• Population growth and demographic pressures • Rural poverty, dependence on climate-sensitive agriculture, and livelihood fragility • Historical legacy of forest conversion and landscape transformation • Systemic marginalization and insecure tenure of Indigenous and tribal groups • Demographic shifts, labor precarity, and social vulnerability • Climate variability and systemic exposure	• Weak integration of biodiversity conservation, water management, and climate adaptation • Inefficient access to productive assets and limited support for tribal and rural communities • Fragmented governance and inadequate transboundary coordination • Insufficient technical capacity, extension services, and climate-science adoption • Social vulnerability reinforced by demographic shifts and labor precarity • Limited infrastructure, irrigation, and early-warning systems • Poor ability to respond to ecological and climatic shocks, including
--	---	--	---

			human-wildlife conflict
--	--	--	----------------------------

7.2 Direct Threats

The following threats represent the primary challenges undermining the region’s role as a global biodiversity hotspot and a critical hydrological water tower:

- **Climate change-driven thermal stress and altered rainfall regimes**

The primary and overarching threat affecting the Western Ghats is anthropogenic climate change, which is rapidly altering temperature and precipitation regimes across the Western Ghats. Mean annual temperatures are projected to rise by 1.5–2.0°C by 2050, with a pronounced increase in night-time minimum temperatures. Heatwave days in high-altitude areas are projected to increase from 4–5 days per year to 47–55 days by the end of the century. In the Nilgiris, the number of heatwave days is projected to increase from a historical average of four days per year to approximately 55 days by the end of the century⁸⁹. These changes increase thermal stress on vegetation and wildlife, with direct implications for climate-sensitive agricultural systems, such as flower abortion in cardamom, and pose severe risks to cold-adapted montane species like the Nilgiri tahr, which depend on cool, frost-prone habitats. Concurrently, rainfall patterns are shifting toward fewer rainy days with more high-intensity precipitation events, fundamentally altering hydrological processes and increasing exposure to floods, droughts, and other climate extremes. Concurrently, rainfall patterns are shifting toward fewer rainy days and more high-intensity precipitation events, fundamentally altering hydrological processes and increasing exposure to climate extremes. These changes are already impacting ecosystems and livelihoods across the Western Ghats, and projections indicate that their severity will intensify in the coming decades. It is therefore critical to understand these dynamics at a landscape level and implement appropriate adaptation and management measures to enhance ecological and socio-economic resilience.

Together, these temperature and precipitation shifts are already impacting ecosystems and livelihoods across the Western Ghats, and projections indicate that their severity will intensify in the coming decades. Understanding these dynamics at a landscape level and implementing effective adaptation and management measures is critical to enhance both ecological and socio-economic resilience.

- **Habitat degradation, conversion and fragmentation**

⁸⁹ Centre for Climate Change and Disaster Management, Dept of Civil Engineering Anna Univeristy (2024), Climate Profile and Projections of Tamil Nadu (Climate Modelling).

Long-standing land-use pressures, combined with climate stress, have driven significant habitat degradation and fragmentation. Over the past century, the Western Ghats has experienced a 35.3% decline in forest cover⁹⁰, with Wayanad losing 62% between 1950 and 2018. Native tropical wet evergreen forests and montane shola-grassland complexes have been largely converted into monoculture plantations of tea, coffee, pepper, rubber, and eucalyptus. This transformation fragments contiguous forest tracts, disrupts critical wildlife corridors, and reduces canopy complexity. As a result, the landscape has lost much of its ability to regulate microclimates, retain soil moisture, and buffer hydrological extremes. Projections indicate that by 2050, habitat suitability for wet evergreen forests will decline by 17–32%⁹¹, while deciduous forests may decline by approximately 11%⁹², with a corresponding expansion of arid thorn forest types, indicating a fundamental ecological restructuring.

- **Ecosystem restructuring, and biological invasions and rising human-wildlife conflict**

The combined effects of climate change, habitat fragmentation, and land-use transformation are driving progressive biodiversity loss and ecosystem simplification across the Nilgiri-Wayanad-Chaliyar Corridor (NCC). Native forests are increasingly fragmented and degraded, and invasive species such as *Lantana camara* and *Senna spectabilis* dominate these altered patches, suppressing native regeneration, altering fire regimes, and reducing habitat quality. Endemic and climate-sensitive species, including the Lion-tailed macaque and Nilgiri tahr, are particularly vulnerable to these ecological changes. The loss of forest connectivity, declining forest productivity, and reduced water availability in forest interiors are simultaneously forcing wildlife, particularly elephants, tigers, and wild boars, into agricultural lands and human settlements in search of forage and water. This movement has intensified human-wildlife conflict, leading to rising incidences of crop damage, livestock loss, human injury, and retaliatory killings. Projections indicate that such conflict is likely to increase by 20–25% over the next three decades, posing a severe threat to biodiversity conservation and the livelihood security of farming and indigenous communities. These intertwined ecological and socio-ecological pressures lock degraded landscapes into low-diversity, high-risk states, undermining the corridor's resilience and its role as a regional biodiversity stronghold.

- **Hydrological stress and emergence of wet-drought conditions**

⁹⁰ Reddy, C. Sudhakar, C. S. Jha, and V. K. Dadhwal. *Assessment and monitoring of long-term forest cover changes (1920–2013) in Western Ghats biodiversity hotspot*. Journal of Earth System Science 125, no. 1 (February 2016): 103–114. Indian Academy of Sciences

⁹¹ Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risks Assessment and Adaptation Plan for Tamil Nadu – Forest Habitat Suitability (Under Climate Studio)

⁹² Centre for Climate Change and Disaster Management, Dept. of Civil Engineering, Anna University, Chennai. (2024). Climate Risk Assessments and Adaptation Plan for Tamil Nadu (Under Climate Studio)

Altered rainfall regimes, combined with forest loss and soil degradation, have produced a severe and growing hydrological imbalance across the corridor. Although projections indicate increases in total annual rainfall in some areas, such as a 26.7–32.6% increase in Coimbatore⁹³, this rainfall increasingly manifests as short, intense events that generate rapid runoff rather than groundwater recharge. As degraded landscapes have lost their capacity to absorb and retain water, much of this rainfall is converted into rapid surface runoff rather than contributing to groundwater recharge. The hydrological consequence is the emergence of persistent wet drought conditions, where heavy monsoon rainfall coexists with severe dry-season water scarcity. The Chaliyar River Basin, which drains the corridor, currently experiences a non-monsoon freshwater deficit of 133.5 MCM, projected to increase to 214 MCM by 2040⁹⁴. This deficit threatens drinking water security, irrigation, and ecosystem functioning across upstream, midstream, and downstream zones, affecting an estimated 1.5 to 2 million people. Water depletion affects irrigation, industry, and domestic supply, while water quality degradation occurs as floods pollute wells and treatment systems and sediments wash into surface waters. In Kerala, the per capita annual availability of freshwater has declined drastically from 14,443 m³ in 1951 to 5,301 m³ in 2021⁹⁵. Reservoir storage capacity is being reduced by sedimentation caused by soil erosion, floods, and landslides (e.g., the Aruvikkara Dam lost 43% of capacity). Saltwater intrusion from sea-level rise threatens coastal aquifers, contaminating freshwater and undermining domestic use.

- **Soil erosion, and climate-amplified landslides**

Soil erosion and landslides are major immediate threats in the Nilgiri-Wayanad-Chaliyar Corridor. Recurrent hydro-meteorological events such as heavy rainfall, floods, and droughts have degraded soil health, reduced nutrient availability, and compromised agricultural productivity. Heavy rains and landslides have caused a massive loss of stored soil water and a reduction in riparian vegetation. The Nilgiri-Wayanad region is characterized by rugged topography, with elevations exceeding 2,600 meters, and thin, highly weathered soils further amplify the risk. Approximately 14.4% of Kerala's land area is classified as landslide-prone, and under high-intensity rainfall, destabilized slopes have increasingly led to catastrophic failures, as exemplified by the 2024 Wayanad landslides. These events represent systemic geomorphological risks exacerbated by climate extremes.

- **Bush fires (forest fires)**

Forest fires are a major manifestation of climate change, and globally, wildfires are becoming more severe as climate variability intensifies. In Kerala, an increased incidence of fires is projected to result in forest dieback and mortality, particularly in vulnerable districts such as

⁹³ Centre for Climate Change and Disaster Management, Dept of Civil Engineering Anna Univeristy (2024), Climate Profile and Projections of Tamil Nadu (Climate Modelling).

⁹⁴ United Nations Environment Programme (UNEP). (2025). Building Climate Resilient Villages: Village Adaptation and Development Action Initiative – Adaptation Fund Concept Note.

⁹⁵ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

Kollam and Wayanad, driving further habitat degradation and increasing ecological vulnerability.

7.3 Indirect threats

- **Unsustainable agricultural practices and land use planning**

Simplified agricultural and forestry systems reduce ecological resilience. As mentioned in earlier sections, traditional mixed forests and crops have been largely replaced by monocultures, tea, coffee, rubber, eucalyptus, leading to Wayanad losing 62% of its forest cover between 1950 and 2018. Traditional food crops, such as paddy, have sharply declined, replaced by cash crops that reduce soil and water retention and heighten susceptibility to floods, droughts, and landslides. These pressures are compounded by unregulated infrastructure and settlement expansion on steep slopes (>22°) and quarrying that destabilize soils, obstruct drainage, and intensify runoff. Agricultural intensification, including heavy reliance on chemical fertilizers and water-intensive crops, further degrades soil health and lowers groundwater tables.

The lack of risk-informed spatial planning and fragmented governance between Kerala and Tamil Nadu prevents coordinated watershed management and climate-sensitive land use regulation. While statutory measures such as Ecologically Sensitive Areas (ESAs) and Coastal Regulation Zones (CRZ) exist, they do not comprehensively integrate climate or slope risk, leaving settlements and agriculture exposed to environmental hazards. Collectively, these practices compromise the landscape's ability to act as a natural sponge, reducing hydrological buffering, accelerating runoff, and increasing soil erosion, landslide frequency, downstream flooding, and water scarcity during dry periods. By undermining ecological resilience and amplifying exposure to climate extremes, unsustainable agriculture and poor land use governance function as indirect drivers that intensify direct threats such as biodiversity loss, forest degradation, soil erosion, and hydrological stress.

- **Constrained adaptive capacity of smallholder farmers**

The adaptive capacity of smallholder farmers in the Nilgiri-Wayanad-Chaliyar Corridor (NCC), particularly for women farmers, is severely constrained, representing a significant indirect threat to both livelihoods and ecosystems. Most farmers in Wayanad cultivate between 0.3 and 2.4 acres and earn annual incomes of only INR 15,000–75,000, leaving households with minimal financial buffers to absorb climate shocks⁹⁶. This economic fragility is compounded by the largely informal nature of employment, which limits income stability and access to credit or risk-sharing mechanisms particularly for women. As a result, smallholders are often unable to invest in essential adaptive measures such as irrigation, soil

⁹⁶ Sundaran, N. K., Radhakrishnan, A., Ravindran, D., Bonny, B. P., & Nandini, N. V. (2024). *Climate change and farmer livelihoods in Wayanad, India: A livelihood vulnerability index assessment*

and water conservation, crop diversification, and climate-resilient inputs, leaving their agricultural systems highly sensitive to floods, droughts, heat stress, and erratic rainfall. Dependence on rainfed monocultures of high-value crops such as coffee, pepper, and cardamom further amplifies vulnerability, indirectly increasing pressure on surrounding forests and water resources. These challenges are compounded for tribal and marginalized communities, including PVTGs such as the Cholanaikka and Kattunayaka, who face declining access to forest resources and weakened forest-based livelihoods, often becoming fully dependent on public support. Out-migration of youth has left an aging and feminized workforce, which bears disproportionate labor burdens, particularly during climate extremes. Together, these socio-economic and technical constraints create a vulnerability trap, where environmental shocks reinforce cycles of poverty, reduce adaptive capacity, and indirectly drive ecosystem degradation, biodiversity loss, soil erosion, and hydrological stress.

- **Weak agricultural extension and climate advisory services**

Access to extension services and climate advisory is limited, particularly for women. Institutions like Krishi Bhavans face staffing shortages, inadequate technical capacity, and insufficient coverage. Farmers often lack timely information on extreme weather, resilient crop varieties, integrated farming practices, and water management techniques. The absence of practical training or advisory support reduces adoption of adaptive measures, such as precision farming, poly-cropping, integrated nutrient management, or drought/flood-tolerant crops. This gap in knowledge and technical support indirectly increases sensitivity to direct threats, such as soil degradation, crop failure, and hydrological stress.

- **Weak governance, policy gaps, and administrative fragmentation**

The NCC spans Kerala and Tamil Nadu, yet governance structures remain fragmented along state lines. Transboundary coordination is minimal, limiting basin-level water management, integrated forest protection, and coordinated climate adaptation strategies. Regulatory frameworks exist but are weakly enforced, while economic development priorities often overshadow environmental sustainability. Spatial planning rarely incorporates landscape dynamics, ecosystem functions, or long-term climate risks, leading to unsustainable land-use decisions such as steep slope road construction and extensive quarrying. These governance gaps exacerbate ecological degradation, compromise water security, and hinder coordinated biodiversity conservation. These governance gaps are compounded by historical decision making which prioritized commercial plantations and economic development over ecosystem conservation and sustainable land use. Limited integration of forestry, agriculture, and water policies, combined with insufficient enforcement of environmental regulations, has perpetuated unsustainable practices. The cumulative effect of these structural and policy shortcomings have weakened the natural capital base, exacerbated biodiversity loss, and increased socio-ecological vulnerability across the corridor.

- **Education, technical knowledge gaps, and limited capacity for adaptation**

Literacy levels among women are relatively high in both Kerala and Tamil Nadu, contributing positively to adaptive capacity and access to climate information. Kerala reports a rural female literacy rate of approximately 97.5%, among the highest in India. While Tamil Nadu has also achieved relatively high literacy outcomes for women, challenges remain in translating educational gains into equal access to climate information, digital technologies, financial services, and decision-making processes. Tribal and rural communities face literacy levels 15–20% below various districts averages, restricting access to scientific climate information, technical training, and knowledge for diversified livelihoods. Limited awareness of ecosystem management, water conservation, and resilient agricultural practices reduces households' ability to respond effectively to environmental stressors. Technical and extension services are unevenly distributed, compounding the challenge of building long-term resilience.

- **Limited availability of agriculture insurance and risk transfer**

Financial capital is a critical determinant of adaptive capacity, yet access to credit remains constrained for smallholders, women and socially marginalized groups. In Kerala, gaps in the coverage and reach of Primary Agricultural Credit Societies (PACS) limit access to short- and medium-term loans in vulnerable districts⁹⁷. This lack of credit prevents investment in essential adaptive measures, including micro-irrigation, soil and water conservation, crop diversification, and climate-resilient inputs. High exposure to climate-sensitive crops like coffee, pepper, cardamom, and ginger further restricts farmers' ability to take risks or implement resilience measures without external financial support. Consequently, households continue to rely on fragile, low-resilience production systems that are vulnerable to temperature extremes, erratic rainfall, and landslides.

Further, agricultural insurance coverage is low and often fails to reach the most vulnerable households. Programs like the Restructured Weather-Based Crop Insurance Scheme (RWBCIS) and Pradhan Mantri Fasal Bima Yojana (PMFBY)⁹⁸ exist but suffer from limited penetration, lack of awareness among farmers, documentation challenges, and partial coverage of hazards and assets. In the absence of effective insurance, climate-induced crop losses directly reduce household income. This exposure increases debt reliance, delays recovery, and discourages investment in climate-resilient agricultural practices, reinforcing vulnerability to recurring climatic events.

- **Chronic underinvestment in infrastructure, services, and adaptive capacity**

⁹⁷ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

⁹⁸ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

Irrigation coverage in the corridor remains below 15%, leaving farmers highly exposed to wet-drought cycles. Decentralized water storage, technical extension, and climate early-warning systems are inadequate. Weak enforcement of risk-informed land-use planning allows unregulated development to continue, exacerbating hydrological and ecological stress. Underinvestment in physical and social infrastructure, combined with limited access to capital and social protection, leaves households and communities unable to prepare for or recover from environmental shocks.

7.4 Root causes

Among the major root causes of environmental degradation, biodiversity loss, and socio-ecological vulnerability in the Western Ghats, and specifically the Nilgiri-Wayanad-Chaliyar Corridor (NCC), are the following:

- **Economic growth and unsustainable consumption patterns**

Rapid economic development and rising consumption have shifted land use from conservation to extraction and infrastructure, intensifying ecological pressure. Unregulated road construction on steep slopes and extensive quarrying have destabilized soils, while the expansion of resorts and homestays fragments habitats and increases local resource extraction. The region's inherent geological vulnerability, 14.4% of Kerala's land is classified as landslide-prone, is further amplified by such unregulated development, which undermines slope stability and disrupts natural drainage. Under conditions of high-intensity rainfall, these destabilized slopes are increasingly prone to catastrophic failure, as seen in the 2024 Wayanad landslides. At the same time, market-driven incentives favor short-term profit from cash crops, plantations, and construction over long-term ecosystem stewardship, indirectly exacerbating soil erosion, water stress, and biodiversity loss.

- **Population growth and demographic pressures**

High population density in the Chaliyar river basin (1.5–2 million people) and in Kerala overall (860/km², more than twice the national average) exerts significant pressure on land, water, and forest resources^{99 100}. Settlement expansion into forest fringes and hazard-prone slopes increases human-wildlife conflict and exposure to floods and landslides. Youth out-migration has resulted in an aging and feminized workforce, reducing labour availability for sustainable, labour-intensive farming practices and forcing reliance on low-diversity, high-risk agricultural systems.

- **Rural poverty, dependence on climate-sensitive agriculture, and livelihood fragility**

⁹⁹ United Nations Environment Programme (UNEP). Baseline assessment of the Wayanad-Coorg-Nilgiri region: Project background documents

¹⁰⁰ Kerala State Action Plan on Climate Change 2023-2030, Department of Environment and Climate Change, Government of Kerala, 2022

The NCC is characterized by widespread rural poverty, with most households earning only Rs. 15,000–75,000 annually, and most of the workforce (nearly 87%) engaged in informal employment. Agriculture dominates the regional economy, particularly rainfed cash crops like coffee, tea, pepper, cardamom, and coconut. This high dependence on climate-sensitive resources exposes households to risks from monsoon variability, floods, droughts, and extreme heat events. Livelihood fragility creates a persistent vulnerability trap, where environmental shocks force families to incur debt or liquidate assets, further limiting their ability to invest in adaptive measures such as irrigation, crop diversification, or soil and water conservation. Smallholder farmers lack access to capital, technical knowledge, and insurance mechanisms, intensifying their exposure to climate and ecological stressors.

- **Historical legacy of forest conversion and landscape transformation**

Decades of anthropogenic pressure have led to a decline in forest cover. Native tropical wet evergreen forests and montane shola–grassland systems have been extensively replaced by commercial monoculture plantations, including coffee, tea, pepper, rubber, and eucalyptus. This historical conversion has permanently reduced the landscape’s natural buffering capacity, weakening its ability to regulate hydrological cycles, retain soil moisture, and moderate local microclimates. The reduction in native forest connectivity has also disrupted wildlife corridors, increased human–wildlife conflict, and intensified the vulnerability of endemic species. The historical transformation of landscapes is therefore a root cause of current ecological stress and socio-economic vulnerability.

- **Systemic marginalization and insecure tenure of Indigenous and tribal groups**

The corridor is home to numerous tribal communities, including Cholanaikka, Kattunayaka, and Paniya, many of whom are Particularly Vulnerable Tribal Groups (PVTGs). Insecure land tenure, bureaucratic delays in land rights recognition, and declining access to forest resources erode traditional ecological stewardship. This marginalization limits participation in formal governance, constrains access to government support systems, and reduces the ability of these communities to implement resilient agricultural or forest management practices. Loss of customary rights and declining forest access has intensified dependence on public assistance and limited long-term adaptive capacity.

- **Demographic shifts, labor precarity, and social vulnerability**

Significant youth out-migration from hill and plantation areas has resulted in an aging and feminized workforce. Women disproportionately shoulder unpaid care and labor burdens, including spending 2–3 additional hours daily collecting water during dry periods. Limited decision-making power and high labor demands further reduce community adaptive capacity. Combined with poverty and limited infrastructure, these demographic shifts reinforce cycles of vulnerability and reduce resilience to climatic and ecological shocks.

