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# Monsoon's Edge: Rain-Rock & Ruin Western Ghats-The Breaking Point

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## AN ABSTRACT

Restoring the hazard-buffering ecosystems of the Western Ghats is essential to re-establish their natural capacity to attenuate runoff, stabilise slopes, and reduce disaster risk in a changing climate. This analytical paper proposes an integrated restoration framework that combines ecological priorities, technical bio-engineering, and institutional-financial reforms to transform fragmented conservation actions into a coherent, range-wide programme with measurable hazard-reduction outcomes. Ecologically, the paper emphasises targeted restoration of shola forests, montane grasslands (shola–grassland mosaics), wetlands, and riparian buffers, which collectively function as a "sponge and net" to delay peak flows and retain soil on steep terrain. It calls for active removal of invasive species such as Eucalyptus and Acacia to enable recovery of native vegetation and habitats, alongside large-scale native-tree planting and fire-prevention measures embedded within national schemes like the National Afforestation Programme and the Green India Mission. These actions aim to rebuild ecosystem mosaics that historically moderated hydrological extremes and maintained slope integrity across the Ghats. On the technical front, the paper advocates native-species bio-engineering on exposed, degraded slopes and road cuts, using deep-rooted indigenous plants to enhance slope cohesion and reduce infrastructure-induced failures at relatively low cost. It further recommends high-resolution, parcel-level GIS mapping to identify, safeguard, and restore critical wildlife corridors and riparian buffers, thereby aligning hazard mitigation with biodiversity connectivity and landscape-scale planning. Institutionally and financially, the analysis argues for replacing isolated, NGO- or division-led initiatives with a coordinated, range-wide ecosystem restoration programme underpinned by explicit hazard-reduction targets and dedicated funding. It proposes mobilising resources from CAMPA (Compensatory Afforestation Fund Management & Planning Authority) and other forestry or climate trusts through a performance-linked fiscal model, where disbursements are contingent on achieving quantifiable ecological indicators such as increases in native canopy cover. To ensure durability and local ownership, the framework integrates restoration with sustainable livelihoods—promoting agroforestry in transition zones and introducing payments for ecosystem services (PES) that provide Gram Sabhas and local communities with a direct economic stake in conservation outcomes. Together, these strategies offer a pathway to rebuild the Western Ghats' natural hazard-buffering functions while strengthening rural livelihoods, institutional accountability, and climate resilience across one of India's most critical mountain ecosystems.

**Keywords:** Western Ghats; disaster risk reduction; landslides; Ecologically Sensitive Area; Gadgil report; Kasturirangan report; land-use zoning; cumulative impact assessment; ecosystem restoration; climate resilience; trans-boundary governance; ecological fiscal transfers

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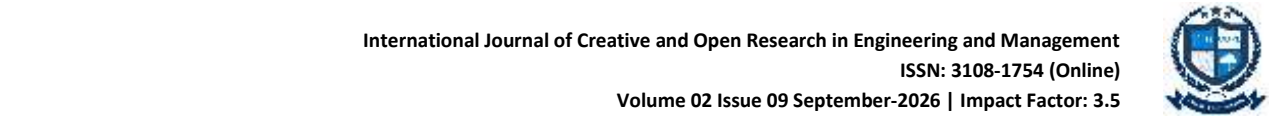

## I-INTRODUCTION

Where the ancient, mist-shrouded spine of India meets the raw fury of the skies, a dramatic transformation unfolds each year on *Monsoon's Edge*. In the Western Ghats, the rains are not merely a season; they are a cataclysmic awakening. Here, where emerald peaks plunge into shadowy valleys, centuries-old fortifications and forgotten monoliths stand as silent witnesses to the relentless assault of water and wind. This is the breaking point of the earth—a perilous yet breath-taking theater where sodden rock fractures, ancient ruins surrender to the encroaching jungle, and nature reclaims its dominion in a symphony of roaring thunder and cascading torrents.

The Western Ghats, where the southwest monsoon collides with ancient peaks, are a landscape of breath-taking beauty and volatile power. Waterfalls carve emerald valleys, yet rock faces fracture and structures crumble under relentless rain. Monsoon life here is a tightrope between vulnerability and defiance, as communities embed resilience into the storm's rhythm. Stretching 1,600 km across six states, the Ghats intercept monsoon rains, feed peninsular rivers, and host extraordinary biodiversity. Yet policy debates have long framed protection as a trade-off against development. This paper reframes the issue: safeguarding the Ghats is a disaster-risk-reduction imperative, not a conservation-versus-growth dilemma. Climate change and aggressive development intensify floods and landslides, exposing governance failures. Evaluating the Gadgil and Kasturirangan reports reveals persistent political resistance to land-use zoning and landscape-scale planning. The authors advocate for a statutory authority to enforce ecosystem restoration, hill-specific engineering, and coordinated, hazard-informed policy. Only through such integrated governance can the cycle of ruin be broken and regional resilience secured.


That framing is increasingly untenable. Each monsoon now produces slope failures, flash floods and debris flows in districts such as Wayanad, Kodagu, Chikkamagaluru, Idukki and the Konkan belt, with heavy loss of life and livelihoods. The physical drivers are well documented: an old, deeply dissected escarpment with thin soils and steep gradients; a warming climate that is concentrating rainfall into shorter, more violent bursts; and a human footprint of quarrying, hill-cutting, road widening, plantation expansion and tourism infrastructure that has weakened natural drainage and slope cohesion. Modelling cited in the source document suggests that a large share of the Karnataka Ghats is already highly susceptible to landslides and that the exposed area could nearly double by mid-century if current trends continue.

The purpose of this paper is therefore to reposition the protection of the Western Ghats as a disaster-risk-reduction (DRR) imperative rather than a purely environmental one. It asks three questions: which areas of action most directly reduce hazard; how well have the existing policy instruments addressed those areas; and what should the states and the Union government do differently. The paper is organised into a methodology section, an identification of key result areas, an analysis of each, a discussion and set of inferences, a SWOT appraisal of the principal reports and the state responses to them, and a concluding set of recommendations.

## II-METHODOLOGY

This is a qualitative, document-based analytical study. It does not generate new field data; instead it synthesises and interrogates existing assessments. The approach proceeded in four steps.

1. *Source review*. The source document titled "Imperative of Western Ghats to Prevent Disasters" was read closely and its factual claims, causal arguments and policy proposals were catalogued. Where it cited secondary material (news reporting, civil-service study platforms, academic journals and official reports), those references were retained for the reference list.

2. *Derivation of key result areas*. The proposals were regrouped into six key result areas, each defined by a disaster-relevant outcome rather than by an administrative sector. The test for inclusion was whether progress in the area could plausibly be measured by a reduction in hazard exposure, vulnerability or loss.

3. *Analytical framework.* Each KRA was examined against three criteria: the strength of the causal link between the intervention and hazard reduction; the current state of implementation across the Ghats states; and the principal constraints to scaling it. Findings were then discussed comparatively to draw cross-cutting inferences.

4. *SWOT appraisal.* The Western Ghats Ecology Expert Panel report (Gadgil, 2011), the High-Level Working Group report (Kasturirangan, 2013) and the series of draft ESA notifications issued by the Ministry of Environment, Forest and Climate Change (MoEFCC) were assessed using a SWOT matrix, with a further section on how the states have acted on them.

Limitations should be acknowledged. The evidence base is uneven: some claims rest on peer-reviewed modelling while others rest on journalistic or explanatory sources. Quantitative figures reported here (for example, the share of the range classified as ecologically sensitive, or tourism carrying-capacity overshoot in specific districts) are reproduced as stated in the source document and should be verified against the primary publications before being used for formal decision-making.

## III-KEY INSIGHTS FROM LITERATURE REVIEW

A literature review on the Western Ghats is anchored in a small set of influential institutions and authors whose work spans biodiversity science, climate and land-use change, ecosystem-service valuation, and community-based conservation. Recent studies (2020–2026) from Indian universities, national research institutes, and international journals extend this foundation with spatially explicit analyses of forest fires, landslides, carbon loss, and eco-environmental risk.

Foundational biodiversity and policy institutions: Core biodiversity assessments and syntheses draw heavily on work by the French Institute of Pondicherry, Pondicherry University, Salim Ali Centre for Ornithology and Natural History (SACON), Wildlife Institute of India (WII), and the Kerala Forest Research Institute (KFRI), alongside global syntheses by IUCN and UNESCO for the Western Ghats World Heritage properties. Policy-oriented debates are framed by the Gadgil Panel (WGEEP, 2011) and Kasturirangan High-Level Working Group (2013), with subsequent analyses by eGyanKosh (IGNOU), Drishti IAS, ClearIAS, and other UPSC-focused institutions that distil institutional recommendations and ESA delineation issues

Land-use change, carbon, and thermal dynamics: Palakkad Gap and beyond: On land-use and climate interactions, a key recent contribution is Viswambharan, Kumaramkandath, Scaria, Pangunni, Tali, and Malik (2026) from the University of Leeds (School of Geography), who integrate Landsat time series and the InVEST carbon model to show built-up expansion, agricultural decline, rising land-surface temperatures, and ~555,000 t of land-based carbon emissions in the Palakkad Gap (1994–2024), with 2034 projections indicating continued warming and carbon-resilience loss. Complementary work by Ramachandran et al. (2026) (affiliated with Tamil Nadu state research institutions) models climate-induced shifts in habitat suitability for dominant forest types in the Tamil Nadu Western Ghats, highlighting vulnerability of evergreen and deciduous formations under future climates.

Eco-environmental risk, landslides, and machine-learning approaches: For hazard and risk mapping, Drisiya and Singh (2026) at IIT Palakkad (ESSENCE and Civil Engineering) apply InVEST Urban Nature Access and Habitat Risk Assessment in Idukki, showing how tourism and infrastructure growth concentrate habitat risk in steep landscapes and overlap with 2018–2020 landslide-affected areas. Landslide susceptibility work includes Sasidharan, Ku, and Cyrus (2026) from Cochin University of Science and Technology, who develop a typology-integrated NFR–Random Forest framework distinguishing debris flows, shallow slides, and rock falls under extreme rainfall. Broader multi-hazard and flood–landslide frameworks for Kerala and the Western Ghats are advanced by researchers such as Mundayatt, Anil, Seth, and Sreevalsan-Nair (2026) and teams using Random Forest and CRITIC-weighted exposure/vulnerability indices, often linked to NCESS landslide susceptibility products.

Forest fires, disturbance regimes, and road mortality: Fire ecology syntheses highlight strong temperature–fire correlations in the Western Ghats, with contributions from climate–fire teams publishing in Springer/Environmental Sciences Europe and related outlets, emphasising drought, heatwaves, and anthropogenic drivers. Wildlife-impact reviews are led by Arjun Viswa Santhasivam, Babu Santhanakrishnan, Arun P. Ramachandran, and Moorthi Mahaly (2026) from SACON (South India Centre of Wildlife Institute of India) and AVC College, who document >6,500 animal deaths from road collisions (1997–2023) across the Ghats and call for safer road design

Ecosystem services, Indigenous perspectives, and valuation: Ecosystem-service valuation with an Indigenous lens is represented by Balasubramanian and Sangha (2023), cited in 2026 reviews, who apply Indigenous mental models and SEEA-EA frameworks to quantify provisioning, regulating, and cultural services in the Western Ghats, estimating annual ES values on the order of US$ 612 million for selected landscapes. Broader meta-analyses (e.g., Wood Central, 2026, drawing on peer-reviewed meta-regression) place India's forest ES at ~₹2.5 trillion/year, with the Ghats contributing disproportionately to water regulation and climate moderation. UNESCO-linked work by teams at the Wildlife Institute of India and partner institutions develops ecological indicator frameworks for long-term monitoring of Outstanding Universal Value in the Sahyadri sub-cluster

Community-based conservation: sacred groves and local institutions: On sacred groves, Meghana Nayak and T. S. Harsha (2026) (affiliated with KSOU, Mysore) synthesise literature on Devara Kadu in Karnataka, emphasising their roles in carbon storage,

nutrient cycling, hydrological regulation, and as reference systems for restoration, while calling for process-based measurements and integration into policy. Classical foundations by Gadgil and Vartak (1976) and later work by Bhagwat, Kushalappa, Williams, and colleagues are repeatedly invoked to position sacred groves as informal protected areas with high medicinal-plant richness and regeneration relative to reserve forests.

Climate impacts on species and habitats: RET species and forest types: Studies on climate-driven vulnerability of Rare, Endangered, and Threatened (RET) species (e.g., amphibians and freshwater fishes) are published in journals such as Journal of Geography, Environment and Earth Science International (JOGEE), highlighting intensified hydro climatic variability and species-specific sensitivities. Habitat-shift modelling for tree species (e.g., Diospyros and dominant forest types) by Jithu K. Jose, Saranya, and colleagues (often linked to Kerala Forest Research Institute and allied institutions) uses MaxEnt and niche-dynamics approaches to project contractions and reconfigurations under future climates.

Synthesis: who is doing what, and where the gaps are: Taken together, the literature is dominated by: (i) biodiversity and conservation science from SACON, WII, KFRI, French Institute of Pondicherry, and Pondicherry University; (ii) land-use, carbon, and thermal analyses from University of Leeds and Tamil Nadu/Kerala state research teams; (iii) risk and hazard mapping from IIT Palakkad, CUSAT, NCESS, and GIS/ML groups; and (iv) ecosystem-service and Indigenous-knowledge work by Balasubramanian, Sangha, and collaborators. Persistent gaps noted across these groups include limited process-based quantification of carbon sequestration, groundwater recharge, and pollination services in sacred groves; weak integration of fine-resolution climate and landslide risk into land-use zoning; and insufficient mainstreaming of ES values into planning and finance

## IV-KEY RESULT AREAS

Six key result areas were derived. Together they trace the pathway from hazard (the physical trigger) through exposure (what is placed in harm's way) and vulnerability (how well people and assets can withstand a shock) to governance (who decides and enforces). Table 1 summarises each KRA, its intended outcome and the indicators by which progress could be judged.

| KRA | Intended disaster-risk outcome | Illustrative indicators |
|---|---|---|
| KRA 1: Hazard-informed land-use and zoning | Development is kept off unstable slopes and out of flood pathways. | Share of high-risk villages covered by high-resolution landslide susceptibility maps; existence of enforced construction moratoria on slopes above roughly 20 degrees; carrying-capacity ceilings for roads, tourism and hydropower. |
| KRA 2: cumulative, landscape-scale environmental assessment | Approvals account for the combined effect of many projects on a basin or corridor. | Number of basin- or corridor-level cumulative impact assessments completed; mandatory slope-stability audits within clearance procedures. |
| KRA 3: Restoration of hazard-buffering ecosystems | Natural systems regain their capacity to slow runoff and bind soil. | Area of shola, grassland, wetland and riparian buffer restored; length of degraded road cuts treated with bio-engineering. |
| KRA 4: Hill-appropriate, climate-resilient infrastructure | Roads and buildings stop creating new failure surfaces. | Adoption of mountain engineering codes; drainage lines cleared of encroachment; culverts and bridges designed to projected rather than historical rainfall. |
| KRA 5: Early warning and community-based risk management | Communities receive timely warnings and hold a formal role in land-use decisions. | Density of rain gauges, radars and slope sensors in high-risk taluks; Gram Sabha and Biodiversity Management Committee participation in approvals; payments for ecosystem services linked to conservation outcomes. |

| KRA | Intended disaster-risk outcome | Illustrative indicators |
|---|---|---|
| KRA 6: Trans-boundary institutional governance | A single empowered authority coordinates protection across six states. | Establishment of a statutory Western Ghats authority; final ESA notification accompanied by socio-economic safeguards and fiscal transfers. |

*Table 1. Key result areas linking Western Ghats protection to disaster prevention*

## IV-ANALYSIS OF THE KEY RESULT AREAS

### 4.1 KRA 1: Hazard-informed land-use and zoning

The causal logic here is the strongest of all six areas. Landslides in the Ghats overwhelmingly occur where steep slopes have been cut, loaded or stripped of vegetation; keeping heavy construction off such ground removes the trigger rather than treating its consequences. The technical means now exist: machine-learning-based susceptibility mapping can resolve risk to the level of individual slopes and settlements. Yet implementation lags badly. Zoning in most Ghats districts remains coarse, approvals are granted parcel by parcel, and carrying-capacity studies for tourism and roads are the exception rather than the rule. The central constraint is political rather than technical, since a moratorium on construction above a threshold gradient directly confronts real-estate, resort and plantation interests.

### 4.2 KRA 2: Cumulative, landscape-scale assessment

Single-project environmental clearances systematically under-count risk in mountain terrain, because slope stability and drainage respond to the sum of quarrying, blasting, cut-and-fill and road networks across a catchment, not to any one of them. Shifting to basin- or corridor-level assessment corrects this blind spot and would also make it harder to fragment large projects into smaller ones to avoid scrutiny. Implementation is at an early stage; cumulative assessment is discussed in policy circles but rarely mandated, and slope-stability audits are not yet a standard condition of clearance in hilly districts. The constraint is institutional capacity as much as will: state pollution control boards and expert appraisal committees are not staffed for geotechnical review at scale.

### 4.3 KRA 3: Restoration of hazard-buffering ecosystems

Shola forests, montane grasslands, wetlands and streamside vegetation function as a sponge and a net: they delay peak flows and hold soil in place. Their restoration is a comparatively low-cost intervention with strong co-benefits for water security and biodiversity, and bio-engineering with deep-rooted native species on exposed road cuts is a proven technique. The weakness is that restoration is slow, its benefits are diffuse and it therefore attracts less funding than visible engineering. Progress has been patchy, driven by individual forest divisions or NGOs rather than by a coordinated programme with hazard-reduction targets.

### 4.4 KRA 4: Hill-appropriate infrastructure

Much of the recent damage in the Ghats has been infrastructure-induced: roads without adequate drainage that channel water into slopes, retaining walls without weep-holes that build up pore pressure, and culverts sized to historical rainfall that are overwhelmed by current extremes. Adopting mountain-specific engineering standards would prevent the creation of new failure surfaces. The good news is that the standards are well understood; the bad news is that road widening and building continue under plains-oriented codes, and encroachment of natural drainage lines by settlements and commercial premises is widespread. Enforcement, retrofitting of existing assets and the cost of designing for future rather than past rainfall are the main hurdles.

### 4.5 KRA 5: Early warning and community-based risk management

Where the other KRAs reduce hazard and exposure, this one reduces vulnerability. Dense networks of automatic rain gauges, Doppler radar and slope-movement sensors, integrated with district disaster-management cells, can provide the hours of warning that turn a fatality into an evacuation. Community participation, through Gram Sabhas and Biodiversity Management Committees, fair application of the Forest Rights Act and payments for ecosystem services, gives local people a stake in protection rather than a grievance against it. Monitoring networks have expanded after recent disasters but remain thin in many high-risk taluks, and local governance bodies are more often consulted after decisions than before them.

### 4.6 KRA 6: Trans-boundary governance

Hazards do not respect state boundaries; a catchment degraded in one state floods a district in another. The Gadgil panel's proposal for a statutory Western Ghats Ecology Authority, and the ESA notification process that followed, are the only instruments designed to operate at the scale of the whole range. Neither has been fully realised. The authority was never constituted, and the ESA has passed through repeated draft notifications without finalisation. This is the KRA with the widest gap between design and delivery, and because it provides the framework within which the other five would be enforced, its stagnation undermines all of them.

## V-DISCUSSION

Three patterns emerge when the six areas are considered together. First, there is an inverse relationship between the strength of the evidence and the degree of implementation. The interventions with the clearest hazard-reduction logic, namely slope zoning and cumulative assessment, are precisely those most resisted, because they constrain land-based economic activity. Interventions that are easier to adopt, such as sensor networks, are valuable but address the consequences of risk rather than its creation.

Second, the six areas are interdependent in a way that punishes partial action. Restored ecosystems will not hold a slope that has been undercut by a road built to the wrong standard; an early-warning network will keep issuing alerts for settlements that zoning should never have permitted. Disaster risk in the Ghats is a systems property, and the governance framework in KRA 6 is the mechanism through which the other five could be pursued coherently. Its absence explains why individual good practices have not added up to a reduction in aggregate losses.

Third, the water-security dimension is under-used as an argument. Because the Ghats are the headwaters for most of peninsular India, their degradation increases reservoir sedimentation, sharpens the swing between floods and droughts, and threatens irrigation, hydropower and urban supply far beyond the hill districts themselves. Presenting protection as a service to downstream cities and farmers, rather than as a sacrifice by hill communities, could broaden the political coalition in its favour and align the agenda with climate-adaptation and Sustainable Development Goal commitments.

A fourth theme concerns equity. Much of the opposition to protection derives from a legitimate fear that costs will fall on smallholders, plantation workers and tribal communities while benefits accrue elsewhere. Any credible regime must therefore pair restrictions with compensation, ecological fiscal transfers to the states and livelihood alternatives. Where this pairing has been absent, as in the reception of the Gadgil recommendations, protection has been portrayed as anti-development and has stalled.

## VI-INFERENCES FROM THE DISCUSSION

The analysis supports the following inferences.

- **Inference 1:** The recurrence of landslides and floods in the Ghats is primarily an outcome of governance and land-use failure, not of scientific uncertainty. The hazard is known, mappable and largely predictable.
- **Inference 2:** Prevention is cheaper than response. Keeping construction off unstable slopes and protecting drainage costs a fraction of post-disaster relief, reconstruction and the economic losses of interrupted transport, tourism and agriculture.
- **Inference 3:** A range-wide institution is a precondition, not an optional extra. Without an empowered authority and a final ESA, states will continue to compete in a race to develop before rules harden.
- **Inference 4:** Legitimacy requires local ownership. Regulation imposed from above without participation, compensation and livelihood pathways has repeatedly failed; a participatory model with clear no-go zones is more likely to endure.
- **Inference 5:** Climate change is shortening the window for action. As extreme rainfall intensifies, damage to slopes and catchments becomes progressively harder and costlier to reverse, so delay is itself a policy choice with mounting consequences.

## VII-SWOT ANALYSIS OF THE PRINCIPAL REPORTS AND STATE RESPONSES

Three instruments have shaped the policy landscape: the Western Ghats Ecology Expert Panel (Gadgil) report of 2011, the High-Level Working Group (Kasturirangan) report of 2013, and the succession of draft ESA notifications issued by MoEFCC through the 2020s together with the responses of state taskforces. Each is assessed below.

### 7.1 Gadgil Committee (Western Ghats Ecology Expert Panel, 2011)

| **Strengths** | **Weaknesses** |
|---|---|
| • Ecosystem-based, precautionary design: graded roughly 64 percent of the range into three sensitivity zones and proposed treating the entire Ghats as an ESA.<br>• Comprehensive sectoral restrictions on mining, thermal power, large dams, SEZs, polluting industry and genetically modified crops in core zones, with tourism regulation.<br>• Institutional innovation through a statutory Western Ghats Ecology Authority with state units and built-in public participation. | • Perceived as socio-economically rigid; provoked fears of displacement and constraints on agriculture and tourism among states, planters and local communities.<br>• Offered no clear transition plan for existing projects or strategy for building federal consensus, leaving it exposed to state vetoes and lobbying.<br>• Did not adequately address revenue loss, compensation or conservation financing. |
| **Opportunities** | **Threats** |

| | |
|---|---|
| • Its strict zoning maps closely onto today's landslide and flood evidence, providing a ready template for the most hazardous ESZ-1 areas.<br>• Can be cited in courts and policy debates to justify stronger safeguards where disasters have already struck.<br>• Its ecosystem approach aligns naturally with climate-resilience, water-security and biodiversity frameworks. | • Sustained multi-state opposition has produced repeated delay and dilution.<br>• Framed by opponents as anti-development, eroding public and political support.<br>• Non-implementation has created a regulatory vacuum that permits continued quarrying, land conversion and risky infrastructure. |

*Table 2. SWOT of the Gadgil report*

### 7.2 Kasturirangan Committee (High-Level Working Group, 2013)

| **Strengths** | **Weaknesses** |
|---|---|
| • Greater political acceptability: confined the ESA to about 37 percent of the range (roughly 60,000 square kilometres of "natural landscape"), sparing most settlements, plantations and farmland.<br>• Clearer, targeted prohibitions on mining, quarrying, thermal power and polluting industry within the ESA, with regulated development permitted elsewhere.<br>• Technically defensible delineation using remote sensing and biological-richness criteria. | • Exclusion of large human-dominated areas risks severing ecological connectivity and under-protecting buffer zones essential to hydrology and slope stability.<br>• Moved from a participatory to a more centralised, expert-led governance model, reducing local ownership.<br>• Multiple draft notifications without finalisation have left boundaries, permitted activities and enforcement ambiguous. |
| **Opportunities** | **Threats** |
| • Represents a workable middle path that could be operationalised with strong incentives and definitive boundary maps.<br>• Concentrates protection on the most intact forests, wildlife corridors and headwater catchments, which are also the most important for DRR.<br>• Provides a platform for state-specific tailoring through taskforces while retaining core no-go zones. | • States continue to contest the ESA extent, village boundaries and satellite-based mapping.<br>• Mining, quarrying, road widening and resort expansion persist in and around the proposed ESA.<br>• Repeated drafts and litigation are breeding policy fatigue, with disasters treated as episodic rather than systemic. |

*Table 3. SWOT of the Kasturirangan report*

### 7.3 Draft ESA Notifications (MoEFCC, 2020s) and State Taskforce Responses

| **Strengths** | **Weaknesses** |
|---|---|
| • Iterative refinement: successive drafts have absorbed state feedback, ground conditions and newer geospatial data.<br>• Explicit lists of prohibited and regulated activities give clearer regulatory signals than earlier instruments.<br>• State-generated evidence, such as Karnataka's taskforce documentation of tourism capacity overshoot of around 300 percent in Kodagu and Chikkamagaluru, strengthens the case for regulation. | • Persistent Centre-state deadlock over boundaries, economic impact and livelihood restrictions stalls final notification.<br>• Satellite-derived ESA boundaries frequently conflict with village records and actual land use, generating administrative and legal disputes.<br>• States shoulder conservation costs without adequate ecological fiscal transfers, weakening their incentive to enforce. |
| **Opportunities** | **Threats** |
| • Recent landslides and floods have opened a political window for faster finalisation and stricter enforcement. | • Prolonged uncertainty encourages race-to-develop behaviour, illegal quarrying and land conversion before rules take effect. |

| | |
|---|---|
| • ESA provisions can be embedded in state DRR plans, river-basin planning and climate-action strategies to unlock funding and co-benefits.<br>• High-risk, high-value taluks can serve as pilot ESAs with robust monitoring, livelihood packages and eco-tourism standards. | • Court challenges and shifting political priorities could further dilute or stall implementation.<br>• Intensifying extreme rainfall is narrowing the window to prevent irreversible slope and catchment damage, raising the cost of inaction. |

*Table 4. SWOT of the draft ESA notifications and state responses*

### 7.4 How the states have acted on the reports

The six states have responded to the reports in broadly similar ways, though with different emphases. Kerala, where plantation and settlement density is highest, has been the most vocal about livelihood impacts and has pressed for the exclusion of inhabited areas and cultivated land from the ESA. Karnataka has constituted a dedicated Western Ghats conservation taskforce that has both documented ecological stress, such as tourism exceeding waste and water carrying capacity in the hill districts, and lodged formal objections to the MoEFCC drafts on boundary and livelihood grounds. Maharashtra, Goa and Tamil Nadu have contested village-level demarcations and sought reductions in the notified area, while Gujarat's stake, at the northern end of the range, is smaller.

The common thread is that state action has been reactive and defensive: substantial effort has gone into contesting the extent and boundaries of the ESA, and comparatively little into building the zoning, assessment and restoration machinery that would reduce disaster risk irrespective of where the ESA line is finally drawn. The taskforce evidence from Karnataka is a notable exception, because it demonstrates that state institutions can generate the data needed to justify regulation. Converting such evidence into enforceable local rules, and matching it in the other states, is the next step.

### 7.5 Commonalties and Differences in the above reports

#### *7.5.1 Commonalities across the three instruments*

All three instruments—the Gadgil report (2011), the Kasturirangan report (2013), and the successive draft ESA notifications with state taskforce inputs (2020s)—share a core diagnostic: the Western Ghats require special protection as an Ecologically Sensitive Area (ESA) because of their unique biodiversity, hydrological functions, and disaster-risk profile. Each proposes spatially explicit zoning or boundary-setting to concentrate the strongest safeguards in the most sensitive parts of the range, and each identifies a short list of "no-go" or highly regulated activities (notably mining, quarrying, thermal power, and polluting industry) within those zones. All three also recognise the need for stronger institutional arrangements than the status quo: Gadgil via a statutory Western Ghats Ecology Authority, Kasturirangan via a more centralised expert-led model, and the draft notifications via iterative rule-making anchored in MoEFCC but informed by state taskforces. Finally, all three implicitly or explicitly link conservation to climate resilience and disaster risk reduction, whether by protecting headwater catchments and slopes, restricting land-use change in fragile zones, or using recent landslide and flood evidence to justify stricter regulation.

#### *7.5.2 Differences in scope, design, and political strategy*

The most striking difference is in spatial scope and social framing. Gadgil treated nearly the entire Western Ghats as an ESA and graded about 64 percent into three sensitivity zones, emphasising a precautionary, ecosystem-wide approach. Kasturirangan narrowed the ESA to roughly 37 percent (around 60,000 sq km) of "natural landscape", explicitly sparing most settlements, plantations and agricultural areas to improve political acceptability. The draft ESA notifications sit between these poles: they retain the idea of an ESA but refine boundaries iteratively using newer geospatial data and state feedback, while also confronting mismatches between satellite-derived lines and village records. On governance, Gadgil's design was more participatory and federal (statutory authority with state units), whereas Kasturirangan shifted toward a centralised, expert-led model that reduced local ownership; the 2020s drafts try to balance both by incorporating state taskforce evidence (e.g., tourism capacity overshoot in Kodagu and Chikkamagaluru) but remain stuck in Centre–state deadlock over who pays and who decides.

#### *7.5.3. Differences in implementation pathways and socio-economic treatment*

The three instruments also diverge in how they treat existing development, livelihoods, and financing. Gadgil was criticised for being socio-economically rigid: it imposed strong sectoral restrictions without a clear transition plan for existing projects, compensation mechanisms, or conservation financing, which fueled state and community resistance. Kasturirangan attempted a softer landing by distinguishing "cultural" from "natural" landscapes, phasing out mining over five years or at lease expiry, and allowing regulated development outside the ESA, but it still left many boundaries and permitted activities ambiguous through multiple draft notifications. The draft ESA notifications go further in listing prohibited and regulated activities and in using state-generated evidence to justify regulation, yet they expose a critical gap: states are expected to shoulder conservation costs without adequate ecological fiscal transfers, weakening incentives for enforcement and encouraging a race-to-develop before rules harden.

### *7.5.4 Differences in risk profiles and policy trajectories*

Finally, the SWOT analyses reveal different risk profiles and likely policy trajectories. Gadgil's strength—its strict, ecosystem-wide zoning—has become a liability in political terms: sustained multi-state opposition has framed it as anti-development, creating a regulatory vacuum that permits continued quarrying and risky infrastructure. Kasturirangan's middle path is technically defensible and more operable, but repeated drafts, litigation, and state contestation over village boundaries and satellite mapping have bred policy fatigue, with disasters treated as episodic rather than systemic. The draft ESA notifications benefit from iterative refinement and recent disaster evidence that opens a political window for finalisation, yet they face the most immediate threat: prolonged uncertainty is incentivising illegal land conversion and intensifying extreme rainfall is narrowing the window to prevent irreversible slope and catchment damage. In practice, this means Gadgil now functions more as a normative and legal reference, Kasturirangan as a negotiable baseline for ESA extent, and the 2020s drafts as the contested arena where boundaries, incentives, and enforcement will ultimately be decided.

## VIII-CONCLUSION

Protecting the Western Ghats is the most effective disaster-prevention investment available to the states of peninsular India. The range's fragility is intrinsic, but the conversion of that fragility into recurring catastrophe is a product of choices about land use, infrastructure and governance. Fifteen years of expert reports have produced a sound scientific basis and a spectrum of policy options, from the comprehensive Gadgil model to the pragmatic Kasturirangan compromise. What has been missing is the political settlement, the institutional machinery and the fiscal arrangements to act on them. The following recommendations are addressed to the Union government, the six state governments and district authorities.

*8.1 Governance and hazard reality*

- Recurrent landslides and floods in the Western Ghats stem mainly from governance and land-use failures rather than scientific uncertainty; hazards are known, mappable and increasingly predictable.moef.gov
- Physical drivers—steep, dissected terrain, thin soils and intensifying extreme rainfall—interact with human pressures such as quarrying, hill-cutting, road widening, plantation and tourism expansion to systematically weaken slope stability and drainage.moef.gov
- Modelling shows that a large share of the Karnataka Ghats is already highly landslide-susceptible, with exposed areas potentially nearly doubling by mid-century if current trends continue.

*8.2 Reframing protection as DRR*

- Framing Ghats protection solely as a conservation–development trade-off is untenable; it must be repositioned as a core disaster-risk-reduction (DRR) and climate-resilience imperative for peninsular India.moef.gov
- Six key result areas—hazard-informed zoning, cumulative assessment, ecosystem restoration, hill-appropriate infrastructure, early warning and community risk management, and trans-boundary governance—together trace the full pathway from hazard to loss.

*8.3 Implementation gaps and political economy*

- The strongest hazard-reduction logic lies in keeping heavy construction off unstable slopes and flood pathways, yet this is also the most politically resisted intervention because it constrains land-based economic activity.moef.gov
- Single-project environmental clearances systematically under-count mountain risk; without basin- or corridor-level cumulative assessments, the combined impact of many small interventions remains invisible until disaster strikes.moef.gov
- Restoration of shola forests, grasslands, wetlands and riparian buffers is a low-cost, high co-benefit intervention that directly reduces runoff peaks and soil loss, but it remains underfunded and fragmented.moef.gov
- Much of the recent damage is infrastructure-induced: roads and buildings designed for plains conditions, with inadequate drainage and undersized culverts, create new failure surfaces under current rainfall extremes.moef.gov
- Early-warning and community-based risk management reduce vulnerability but cannot compensate for settlements and assets placed in harm's way by weak zoning and clearance practices.moef.gov
- Trans-boundary governance is the enabling framework for all other interventions; the failure to constitute a statutory Western Ghats authority and finalise the ESA undermines the entire DRR architecture.moef.gov
- There is an inverse relationship between evidence strength and implementation: the interventions with the clearest hazard-reduction logic (slope zoning, cumulative assessment) face the strongest political opposition.moef.gov

*8.4 Policy instruments and state responses*

- The Gadgil, Kasturirangan and draft ESA instruments all agree on the need for an ESA, no-go activities and stronger institutions, but differ in spatial scope, governance design and socio-economic treatment, producing policy ambiguity and delay.moef.gov

- States have responded largely by contesting ESA boundaries and livelihood impacts rather than building the zoning, assessment and restoration systems that would reduce risk regardless of where the final ESA line is drawn.moef.gov
- Climate change is narrowing the window for preventive action: as extreme rainfall intensifies, slope and catchment damage becomes progressively harder and costlier to reverse, making delay itself a high-cost policy choice.

## IX-RECOMMENDATIONS

*9.0 Restoration and Protection Framework*

Stretching like an emerald spine down the south-western edge of the Indian peninsula, the Western Ghats represent one of the world's most irreplaceable biodiversity hotspots, yet they face unprecedented ecological and climatic pressures. To safeguard this vital landscape, a comprehensive governance framework has emerged—bridging spatial zoning, statutory oversight, and community-driven green economics. From designating core Ecologically Sensitive Areas (ESAs) and implementing stringent sectoral bans on mining and heavy industry, to deploying real-time GIS monitoring and performance-based fiscal incentives, this multi-layered blueprint offers a robust roadmap for balancing human livelihoods with planetary survival.

| Dimension | Key Elements / Instruments | Typical Provisions / Actions |
|---|---|---|
| *Spatial zoning & ESA classification* | • Ecologically Sensitive Areas (ESA) – ~60,000 km² (≈ 37 % of the WG)<br>• Ecologically Sensitive Zones (ESZ-1, 2, 3) | **ESZ-1** – "core" protection: no new dams, mining, thermal plants, large townships.<br>**ESZ-2** – moderate restrictions; regulated development, stringent environmental clearances.<br>**ESZ-3** – transition zone: sustainable-livelihood programmes, agro-forestry, subject to carrying-capacity assessments. |
| *Statutory & institutional architecture* | • Environment (Protection) Act 1986 (EPA)<br>• Proposed Western Ghats Ecology Authority (WGEA)<br>• Cooperative-federalism mechanisms (state-level units, Gram Sabha participation)<br>• Blueprint's five-volume structure (spatial baseline, statutes, socio-economic, climate-risk, fiscal) | – ESA notified under EPA 1986 to prohibit/ regulate damaging activities.<br>– WGEA as apex statutory body with state-level chapters; participatory governance through Gram Sabhas and expert panels.<br>– Blueprint organises implementation into five dedicated volumes for integrated planning. |
| *Sectoral bans & regulatory filters* | • Mining & quarrying (incl. sand)<br>• Thermal power & "red-category" high-pollution industries<br>• Large-scale construction / townships (e.g., > 20,000 m²)<br>• Major linear infrastructure (highways, railways) | – Absolute prohibition on new mining, quarrying, sand-mining inside ESAs.<br>– Ban on new thermal-power plants and other red-category polluters.<br>– Restrictions on large-area construction and any linear infra without rigorous, multi-criteria clearance (environmental, social, climate). |
| *Restoration & ecological recovery* | • National Afforestation Programme & Green India Mission<br>• Shola-grassland restoration, invasive-species control<br>• Corridor safeguarding, riparian buffer creation | – Large-scale native-tree planting, fire-prevention, landscape-level restoration under national programmes.<br>– Targeted restoration of shola-grassland mosaics, removal of invasive species (e.g., *Eucalyptus*, *Acacia*).<br>– Parcel-level mapping to identify and protect wildlife corridors and riparian buffers. |
| *Livelihoods, equity & green economy* | • Agro-forestry & eco-sensitive livelihoods<br>• Ecosystem-service incentives | – ESZ-3 zones allow traditional activities, climate-smart agro-forestry, regulated eco-enterprises (e.g., non-timber forest |

| Dimension | Key Elements / Instruments | Typical Provisions / Actions |
|---|---|---|
| | (Payments for Ecosystem Services, Community Forest Rights)<br>• "Green-equity" measures (skill-upgrading, market access) | products).<br>– Blueprint proposes incentive schemes that align local incomes with conservation outcomes (e.g., carbon credits, biodiversity offsets).<br>– Capacity-building programmes for women, tribal youth, and small-holder farmers. |
| *Climate security & disaster-risk reduction* | • Landslide & flood-risk mapping<br>• Hazard-monitoring & early-warning systems<br>• Climate-resilient land-use planning | – Integration of slope-stability, catchment-runoff, and climate-risk screens into zoning decisions.<br>– Prioritisation of risk-reduction measures (re-vegetation of steep slopes, check-dam networks) after extreme rainfall events.<br>– Adaptation pathways embedded in the Blueprint's "climate & disaster risk" volume. |
| *Fiscal architecture & financing* | • CAMPA (Compensatory Afforestation Fund Management & Planning Authority)<br>• Green-funds, biodiversity-trusts, performance-based incentives | – Allocation of CAMPA and other forestry/climate funds for on-ground restoration, wildlife monitoring, and community-led projects.<br>– Blueprint outlines a performance-linked fiscal model: payments released upon achievement of measurable ecological targets (e.g., increase in native canopy cover, reduction in illegal mining incidents). |
| *Monitoring, compliance & enforcement* | • High-resolution parcel-level GIS mapping<br>• Violation-tracking dashboards<br>• Lokayukta / judicial oversight mechanisms | – Real-time satellite & drone monitoring linked to GIS parcels to enforce zoning limits.<br>– Centralised violation-tracking portal accessible to state agencies, NGOs, and the public.<br>– Recent Karnataka Lokayukta interventions showcase stronger audit, penalties, and public-interest litigation under the Blueprint. |

*9.1 Institutional and legal architecture*

- Finalise the ESA with a hazard overlay: issue the final ESA notification without further delay, adopting the Kasturirangan natural-landscape core as the minimum, with a statutory commitment to review buffer areas against updated landslide and flood susceptibility data.moef.gov
- Establish a Western Ghats Ecology and Resilience Authority: constitute the statutory authority envisaged by the Gadgil panel, with state chapters, a DRR mandate and the power to coordinate land-use norms and clearances across all six states.moef.gov

*9.2 Land-use, assessment and engineering*

- Enforce slope and drainage moratoria: prohibit heavy construction, resorts and new highways on slopes above roughly 20 degrees and in mapped drainage corridors, using high-resolution susceptibility maps that are published and legally binding at village level.moef.gov
- Mandate cumulative impact assessment: replace project-by-project clearances in hill districts with basin- and corridor-level assessments, and make geotechnical slope-stability audits a non-negotiable condition of environmental clearance.moef.gov
- Adopt hill-engineering standards: issue and enforce mountain-specific engineering codes for roads and buildings, remove encroachments from natural drainage lines, and size culverts and bridges to projected extreme rainfall.moef.gov

*9.3 Restoration, monitoring and community governance*

- Fund a range-wide restoration programme: launch a coordinated programme to restore shola, grassland, wetland and riparian buffers and to apply bio-engineering on degraded slopes and road cuts, with explicit hazard-reduction targets and dedicated funding.moef.gov
- Build dense monitoring and early-warning networks: extend rain-gauge, radar and slope-sensor networks to every high-risk taluk and integrate them with district disaster-management systems and community alert channels.moef.gov
- Embed community governance: give Gram Sabhas and Biodiversity Management Committees a formal role in land-use decisions, implement the Forest Rights Act fairly, and introduce payments for ecosystem services tied to conservation outcomes.moef.gov

*9.4 Incentives and demonstration*

- Create an equitable incentive architecture: introduce ecological fiscal transfers from the Union to the Ghats states and compensation and livelihood packages for affected communities, so that the costs of protection do not fall disproportionately on those who live in the hills.moef.gov
- Pilot and demonstrate: designate selected high-risk, high-conservation-value taluks as pilot ESAs with full monitoring, livelihood support and eco-tourism standards, and use their results to build public confidence for range-wide roll-out

9.5 *Hazard-buffering ecosystems of the Western Ghats:* To restore the hazard-buffering ecosystems of the Western Ghats and regain their natural capacity to slow runoff and bind soil, the analytical paper recommends several key strategies across ecological, technical, and institutional dimensions:

*9.5.1 Targeted Ecological Restoration and Invasive Control*

- Restoring Key Ecosystem Mosaics: Prioritise the restoration of shola forests, montane grasslands (shola-grassland mosaics), wetlands, and riparian buffers (streamside vegetation). These ecosystems function "as a sponge and a net" to delay peak water flows and hold soil in place.
- Controlling Invasive Species: Actively remove invasive species, such as *Eucalyptus* and *Acacia*, to allow native vegetation and habitats to recover.
- Afforestation and Fire Prevention: Implement large-scale native-tree planting and fire-prevention measures. These should be integrated into existing national frameworks, such as the National Afforestation Programme and the Green India Mission.

*9.5.2 Slope Stabilisation and Technical Bio-Engineering*

- Native-Species Bio-Engineering: Apply bio-engineering using deep-rooted native species on exposed, degraded slopes and road cuts. This is a proven, relatively low-cost technique to improve slope cohesion and prevent infrastructure-induced failures.
- Corridor and Buffer Mapping: Use high-resolution parcel-level GIS mapping to identify, safeguard, and restore critical wildlife corridors and riparian buffers.

**9***.5.3 Programmatic and Financial Restructuring*

- Range-Wide Coordinated Programme: Replace the current fragmented, patchy efforts led by isolated NGOs or individual forest divisions with a coordinated, range-wide ecosystem restoration programme. This programme must be backed by explicit hazard-reduction targets and dedicated funding.
- Performance-Linked Financing: Mobilise funds from CAMPA (Compensatory Afforestation Fund Management & Planning Authority) and other forestry or climate trusts. Release these funds using a performance-linked fiscal model, where payments are tied to the achievement of measurable ecological targets, such as increases in native canopy cover.
- Local Livelihood Integration: Align restoration with sustainable local livelihoods, such as agroforestry in transition zones, and introduce payments for ecosystem services (PES) to give local communities and Gram Sabhas a direct economic stake in conservation outcomes

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## XI-ETHICAL CONSIDERATIONS

This research uses publicly available secondary data with ethical adherence to proper citations and avoiding confidentiality breaches & duly acknowledges the application of AI tools where necessary

## XII-LIST OF ACRONYMS

| | |
|---|---|
| AI | Artificial Intelligence |
| AVC | A.V.C. College |
| CAMPA | Compensatory Afforestation Fund Management and Planning Authority |
| CCA | Cumulative Carrying-capacity Assessment |
| CEA | Cumulative Environmental Assessment |
| CUSAT | Cochin University of Science and Technology |
| DRR | Disaster Risk Reduction |
| EPA | Environment (Protection) Act |
| ES | Ecosystem Services |
| ESA | Ecologically Sensitive Area |
| ESZ | Ecologically Sensitive Zone |
| ESSENCE | Environmental Sustainability and related research initiative at IIT Palakkad |
| GIS | Geographic Information System |
| IGNOU | Indira Gandhi National Open University |
| IIT | Indian Institute of Technology |
| IUCN | International Union for Conservation of Nature |
| JOGEE | Journal of Geography, Environment and Earth Science International |
| KFRI | Kerala Forest Research Institute |
| KRA | Key Result Area |
| KSOU | Karnataka State Open University |
| ML | Machine Learning |
| MoEFCC | Ministry of Environment, Forest and Climate Change |
| NCESS | National Centre for Earth Science Studies |
| NGO | Non-Governmental Organisation |
| NFR | Natural Forest–related classification/framework, as used in the study |
| PES | Payments for Ecosystem Services |
| RET | Rare, Endangered and Threatened |
| RF | Random Forest |
| SACON S | alim Ali Centre for Ornithology and Natural History |
| SEEA-EA | System of Environmental-Economic Accounting—Ecosystem Accounting |
| SEZ | Special Economic Zone |
| SWOT | Strengths, Weaknesses, Opportunities and Threats |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UPSC | Union Public Service Commission |
| WGEA | Western Ghats Ecology Authority |
| WGEEP | Western Ghats Ecology Expert Panel |
| WII | Wildlife Institute of India |

## XIII-REFERENCES

The references below are drawn from the sources cited in the attached document. Where the document provided only an outlet name, the outlet is listed and the full citation should be completed from the original before formal publication.

1. Western Ghats Ecology Expert Panel (2011). Report of the Western Ghats Ecology Expert Panel (Chair: Madhav Gadgil). Ministry of Environment and Forests, Government of India.
2. High-Level Working Group on the Western Ghats (2013). Report of the High-Level Working Group on Western Ghats (Chair: K. Kasturirangan). Ministry of Environment and Forests, Government of India.
3. Ministry of Environment, Forest and Climate Change (2020s). Draft notifications declaring Ecologically Sensitive Areas in the Western Ghats (successive drafts up to the seventh).
4. Insights on India (13 July 2026). "UPSC Editorial Analysis: The Fragility of Western Ghats." https://www.insightsonindia.com/2026/07/13/upsc-editorial-analysis-the-fragility-of-western-ghats/
5. The New Indian Express (22 August 2026). "Karnataka's Western Ghats panel pens its objections to MoEFCC." https://www.newindianexpress.com/states/karnataka/2026/Aug/22/karnatakas-western-ghats-panel-pens-its-objections-to-moefcc
6. Drishti IAS. "Western Ghats Ecologically Sensitive Area: 7th Draft Notification." https://www.drishtiias.com/daily-updates/daily-news-analysis/western-ghats-ecologically-sensitive-area-7th-draft-notification

7. Times Now News. "Explained: Gadgil report on erosion in Western Ghats and implementation hurdles." https://www.timesnownews.com/mirror-now/in-focus/article/explained-gadgil-report-on-erosion-in-western-ghats-and-implementation-hurdles/480086
8. SuperKalam (10 January 2026). UPSC Mains answer-writing model answer on the Western Ghats. https://superkalam.com/upsc-mains/answer-writing-challenge/10-01-2026/model-answer
9. Nature (journal). Peer-reviewed research on monsoon intensification and landslide risk in the Western Ghats, as cited in the source document.
10. Taylor & Francis Online (tandfonline). Research on machine-learning-based landslide susceptibility mapping in the Western Ghats, as cited in the source document.

11. Bangalore Mirror (Times of India group). Reporting on landslide susceptibility projections for the Karnataka Western Ghats to 2050.
12. The Telegraph India. Reporting on geological fragility and human-induced landscape stress in the Western Ghats.
13. The Quint. Reporting on drainage encroachment and flood dynamics in the Western Ghats.
14. The Times of India. Reporting on early-warning and monitoring networks in landslide-prone taluks.
15. Mongabay India. Reporting on ESA delineation, draft notifications and remaining natural landscapes in the Western Ghats.
16. The Indian Express. Reporting on the Gadgil panel's institutional recommendations.
17. eGyanKosh (IGNOU). Course material on the Gadgil and Kasturirangan reports.
18. ClearIAS, Vajiram and Ravi, PW OnlyIAS, and Ajmal IAS Academy. Explanatory notes on the Western Ghats reports and ecosystem restoration.
19. Wikipedia. "Western Ghats" and related entries on the Kasturirangan report.