Review Paper:

Evaluating the Goa State Action Plan on Climate Change (2023–2033): Achievements, Gaps and Future Directions

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Abstract

The State Action Plan on Climate Change (SAPCC) of Goa (2023–2033) provides a comprehensive framework for addressing the State's growing climate vulnerabilities. Anchored in the larger framework of India's National Action Plan on Climate Change (NAPCC) and international climate commitments, the plan outlines both mitigation and adaptation measures across critical sectors.

This study critically evaluates the SAPCC, highlighting its achievements in planning and stakeholder involvement, identifying significant gaps in data, finance and institutional mechanisms and proposing future directions for strengthening climate resilience in Goa.

Keywords: Climate Change, Action Plan, Sustainability, Resilience, Vulnerability.

Introduction

Climate change is one of the most pressing global challenges of the 21st century and its manifestations are particularly acute in coastal regions[1]. Climate change is no more an abstract or distant worry; it is a real and current problem that is hurting communities all over India. In the last few years, the country has had longer and stronger heat waves that put people's health, farming and energy systems at risk. Rainfall patterns that used to be very stable are now all over the place, causing terrible floods in some places and long-lasting droughts in others. The coastal States are facing the double threat of rising sea levels and coastline erosion. These problems threaten both people's livelihood and vulnerable ecosystems.

The scope of the disturbance is even more clear when you look at forest fires, loss of biodiversity and changes in disease patterns. These are not separate events; they are all connected and put a lot of stress on social, economic and ecological systems. The literature about climate change adaptation and mitigation techniques, especially within the framework of state action plans, demonstrates a complicated relationship between environmental sustainability and socio-economic advancement.

Chandram[3] looked at how India's climate policies have changed over time and said that boosting renewable energy and planting trees are both important for adaptation and mitigation. He stresses that these programs are very important for human development, but switching from cheap fossil fuels to more expensive renewable energy sources is very hard on the economy. This shows how important it is to find a balance between development requirements and environmental needs. It also suggests that investing in renewable energy and planting trees over the long term can help people develop, even if it costs money at first. [2]

Patra[9] expanded on this by talking about how State Action Plans on Climate Change (SAPCCs) might help subnational governments to lead the way in planning for adaptation. He observed the growing interest in improving these plans to make them more resilient to climate change and to include climate change in development initiatives. It is important to have strong scientific data at the micro level because present capacity limits make it hard to do good impact assessments. This study discusses how the private sector is starting to play a bigger role in creating partnerships that promote research and innovation, especially through programs like Smart Cities. This shows a change toward planning for growth that is both climate-resilient and interconnected.[3,4]

Kumar, Hazra and Dey[7] conducted a critical examination of national adaptation policies, highlighting a pronounced emphasis on adaption measures to protect livelihoods while concurrently addressing mitigation efforts. Their assessment finds that there is a lack of research on climate-induced human migration, especially in delta regions that are vulnerable and need skill development to avoid possible ethnic conflicts. This shows that we need to have complete policies for managing migration and giving people more power in order to deal with future climatic problems. It also shows that we need to take a holistic approach when planning.[4]

Tam[11] talks on tourism in Sri Lanka and shows how important it is for national frameworks and planning tools to work together. The historical background of Sri Lanka's environmental policies and how they have changed over time to become an organized response to climate change shows that the Government is taking steps to protect the environment. The creation of the Climate Change Secretariat and the passing of the National Climate Change Policy show that climate change is seen as a real and present danger. Tam's[11] examination of targeted adaption measures for the tourism industry underscores the imperative for strategic planning to address climate effects, emphasizing the

enhancement of preparation and the promotion of sustainable practices.[5]

Lastly, the work of Busayo and Tolulope[1] showed how important it is to quickly identify the risks of climate change and disasters, especially in cities along the ocean. Their findings show that coastal areas are especially vulnerable to several climate hazards, thus they need specific measures for adapting and reducing disaster risk. This shows how important it is for urban planning and climate resilience to work together. It also shows that thorough evaluations are necessary to come up with good ways to deal with the many problems that climate change causes.[6]

Recognizing the urgency of climate action, the Government of India introduced the National Action Plan on Climate Change (NAPCC) in 2008, which was later complemented by State Action Plans (SAPCCs) to ensure state-specific responses [7]. State Action Plans for Climate Change (SAPCCs) are very essential policy tools in this case. Unlike broad national policies, SAPCCs let each State make plans that take into consideration its specific geography, economy and problems. A coastal State might put protecting tourism infrastructure, mangroves and fisheries at the top of its list of things to do. A State in the Himalayas might put glacier melt, landslides and farming in the mountains at the top of its agenda. SAPCCs assist Governments to establish a balance between adaptation methods like building robust infrastructure, supporting climate-smart farming, safeguarding natural ecosystems and mitigation initiatives like expanding renewable energy and lowering emissions. These plans are important tools for dealing with the climate disaster because they link national climate goals to actions on the ground.

The SAPCC for Goa (2023–2033) is a part of India's larger plan to deal with the problems that climate change is causing at the state level [8]. It was written to be in line with the National Action Plan on Climate Change (NAPCC) so that long-term climate strategies take into account regional issues, sectoral weaknesses and local needs. The plan focuses on Goa's unique ecological and social-economic situation, especially its vulnerable coastal habitats, the Western Ghats, which are home to a lot of different species and its significant reliance on tourism and fishing. Drafted in the early 2020s, the SAPCC seeks to guide the State's climate policies for the decade ahead, ensuring that development goals remain compatible with sustainability and resilience. It makes sure that development goals are still in line with sustainability and resilience.

The uniqueness of Goa's SAPCC lies in its participatory development, with consultations involving universities, research institutions, government departments, civil societies and local communities.[8] It seeks to address both mitigation (by reducing emissions from key sectors such as transport and energy) and adaptation (by safeguarding agriculture, water resources, health and ecosystems). The plan also attempts to mainstream climate considerations into State budgeting and institutional mechanisms, thereby making climate action a cross-sectoral priority.[8]

However, while the SAPCC presents an ambitious framework, it is not without limitations. The complexity of Goa's socio-economic landscape, dependence on external power sources and reliance on fragile ecosystems call for a critical evaluation of how far the plan addresses ground realities. This research study, therefore, evaluates the SAPCC with a threefold objective: to identify its achievements, to expose its shortcomings and to suggest practical future directions for making Goa a model for coastal climate resilience.

Study Area

Goa is India's smallest State by land and is located on the western coast, overlooking the Arabian Sea. Goa is a province that covers around 3,702 square kilometres and is located between the parallels of 14° 53' 57" North to 15° 47' 59" North latitude and 73° 40' 54" to 74°53'11" East longitude.[9] It is famous for its beautiful coastal scenery, rich cultural history and diverse ecosystems. The State has a tropical monsoon climate, which means that summers are warm, winters are pleasant and there is a lot of rain. The Western Ghats, a worldwide recognized biodiversity hotspot, are rough hills that make up the geology of the area. The coastal lowlands are fertile. This natural environment not only supports a variety of habitats, but it also makes Goa more vulnerable to problems caused by climate change like flooding, shoreline erosion and irregular rainfall (Fig. 1).

Goa has a unique socio-economic profile that goes beyond its physical location.[10] It has one of the highest literacy rates in the country and a rather high standard of living. Tourism, mining, agriculture and fishing are the main drivers of the State's economy. Every year, millions of people come to its beaches, churches, temples and lively festivals.[11] At the same time, traditional jobs like farming and fishing are still crucial for making a living, especially in rural and coastal areas. But Goa is becoming more and more vulnerable to climate change since it depends on natural resources and is growing quickly in cities and infrastructure. The State has made balancing economic growth with ecological stability a top policy goal.

This study adopts a qualitative, document-based research methodology to critically evaluate the Goa State Action Plan on Climate Change (SAPCC) 2023–2033. [8] The analysis is based mostly on the official SAPCC report from the Government of Goa, but it also uses secondary sources such as National policy documents (NAPCC), IPCC reports and relevant peer-reviewed. A thematic framework was employed to assess the SAPCC across dimensions including alignment with national and global commitments, participatory processes, scientific rigor, sectoral strategies, financial planning and institutional mechanisms. A comprehensive examination of each part of the strategy was

done to find successes, point out shortcomings and suggest new paths. The methodology was interpretative, emphasizing critical reading, information synthesis and contextual evaluation over quantitative modelling. This approach allows for an in-depth understanding of the policy document within the broader discourse of climate governance and coastal resilience in India.

Achievements of the Goa SAPCC

1. Alignment with National and Global Frameworks

The SAPCC fits in very well with both national and international climate change frameworks. At the national level, it is similar to the goals of the National Action Plan on Climate Change (NAPCC), which includes promoting solar energy, making energy use more efficient, supporting sustainable agriculture, saving water and planting trees. Goa's SAPCC includes these missions in its own sectoral priorities, making sure that State-level plans support India's overarching climate strategy. In addition, the plan reflects the specific guidance provided by the Ministry of Environment, Forest and Climate Change (MoEFCC) to all States to prepare action plans consistent with the NAPCC.[7]

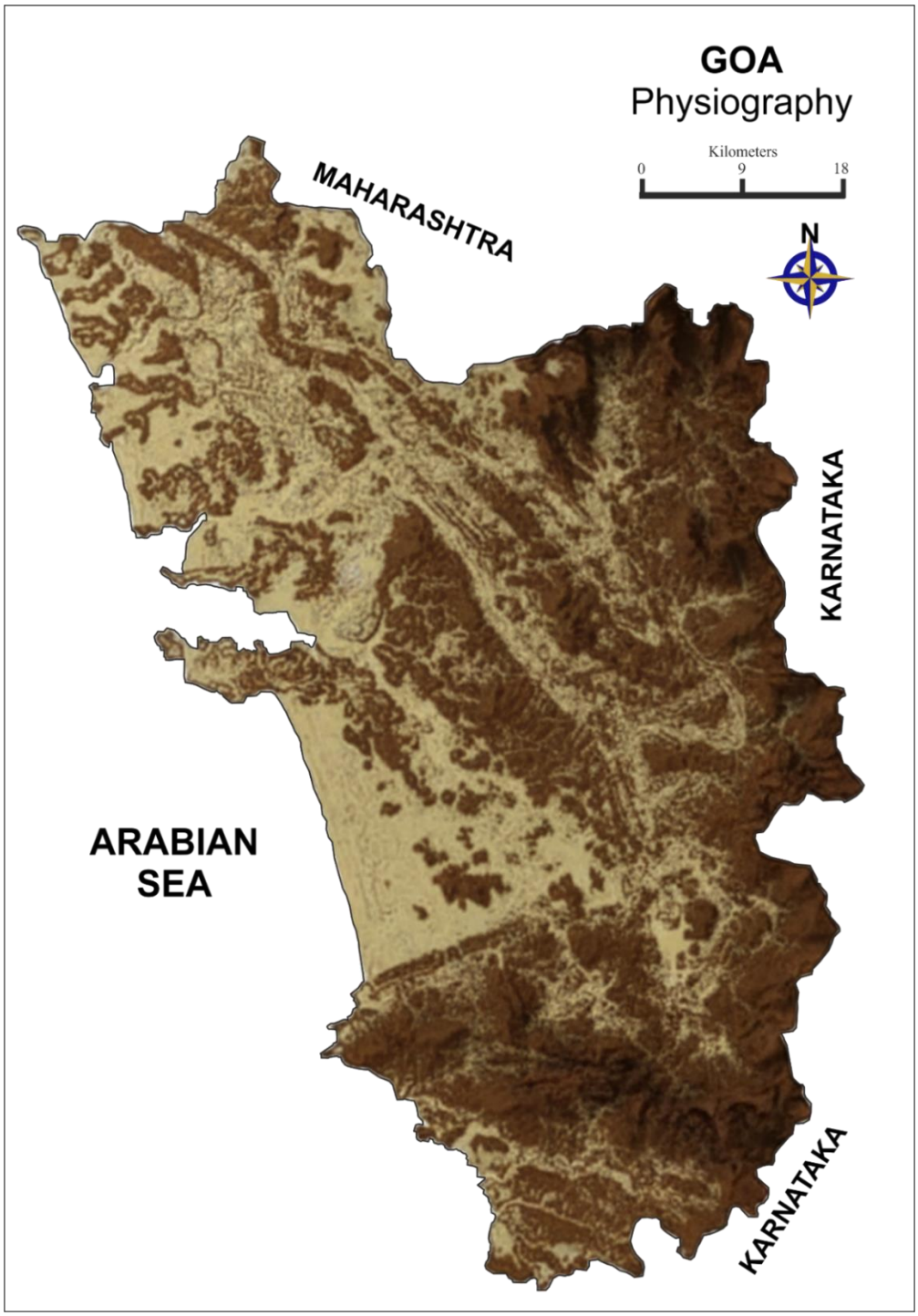

Figure 1: Physiographic Map of Goa

The SAPCC is in line with India's commitments under the Paris Agreement, especially the Nationally Determined Contributions (NDCs). These goals are to cut the emissions intensity of GDP by 33–35% from 2005 levels, raise the share of non-fossil fuel-based electricity to 40% by 2030 and make more carbon sinks. The Goa SAPCC adds to these national goals by suggesting ways to cut emissions through the use of renewable energy, the switch to electric vehicles, waste-to-energy projects and ecosystem-based adaption measures including restoring mangroves and forests.

The SAPCC also puts Goa in the context of the Sustainable Development Goals (SDGs), especially goal 13 (Climate Action). It also indirectly supports goals 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 11 (Sustainable Cities and Communities), 14 (Life Below Water) and 15 (Life on Land). The focus on including climate issues in development planning shows that people know that climate change is not just a problem on its own, but one that affects health, gender equality, poverty reduction and sustainable livelihoods.

The SAPCC also recognizes the importance of worldwide scientific assessments, such as the IPCC Sixth Assessment Report (2021), which stresses the need for localized adaptation and mitigation. Goa's SAPCC tries to make climate strategies more relevant to the State by using global results and merging them with national policy frameworks. This is in line with India's global obligations. This connection makes the Goa SAPCC more credible by putting it in a multi-level governance framework that links local situations to national plans and global promises. But even while the alignment is strong in desire, the problem is still to make sure that Goa's unique goals help India meet its national and global commitments in a real and measurable way.

2. Participatory and Consultative Approach

One of the most notable achievements of the Goa SAPCC is its emphasis on participatory and consultative processes. The preparation of the plan was not confined to technical experts alone but actively involved a broad range of stakeholders. These included representatives from Government departments, academic and research institutions, civil society organizations, industry stakeholders and community-based entities such as Biodiversity Management Committees (BMCs). By engaging such a wide spectrum of actors, the SAPCC sought to ensure that the strategies formulated were rooted in local realities and enjoyed broader legitimacy.

The consultative process was organized through workshops, stakeholder meetings and collaborative dialogues. Academic institutions in Goa, such as universities and research centers, provided scientific inputs and vulnerability assessments. Civil society organizations brought forward concerns related to local livelihoods, social equity and environmental justice. Local communities, particularly those living in coastal zones and flood-prone areas, contributed practical knowledge about observed climate changes, traditional coping strategies and specific vulnerabilities. The participation of BMCs was particularly important, as they hold legal authority under the Biological Diversity Act to manage biodiversity at the grassroots level, making them vital custodians of ecosystem-based adaptation.

Importantly, the SAPCC also attempted to incorporate perspectives from sectors that are often underrepresented in climate policy dialogues, such as the tourism industry, small-scale fisheries and rural women's groups. Their inclusion highlights an awareness that effective climate action must be socially inclusive and economically viable. The consultative approach also provided an opportunity to identify potential conflicts of interest between development priorities and conservation imperatives for example, between tourism growth and coastal ecosystem protection and to attempt reconciliation through dialogue.

In sum, the participatory and consultative approach of the Goa SAPCC represents a positive step towards inclusive climate governance. It acknowledges the value of local knowledge, enhances legitimacy and creates opportunities for shared ownership of climate action. Nevertheless, the effectiveness of this approach will depend on how consistently and meaningfully these stakeholders are engaged during the implementation phase, not merely during the drafting stage.

3. Climate Science and Vulnerability Mapping

The Goa SAPCC demonstrates commendable effort in integrating scientific data and climate modeling into its vulnerability assessment. Drawing upon datasets from the India Meteorological Department (IMD), the National Centre for Polar and Ocean Research (NCPOR) and international climate projections such as CMIP5 and CORDEX, the plan provides a scientific basis for anticipating climate risks. According to these projections, mean annual temperatures in Goa are expected to rise by approximately 2°C by the 2030s and up to 4°C by the 2080s, significantly altering the State's thermal profile and impacting agriculture, health and biodiversity. Rainfall patterns are also projected to become increasingly erratic, with a rise in heavy rainfall events coupled with a reduction in moderate rainfall days, thereby intensifying both drought and flood risks.

The SAPCC that also incorporates flood vulnerability mapping that reveals nearly 14.73% of Goa's land area is highly flood-prone. Talukas such as Salcete, Tiswadi and Bardez emerge as critical hotspots, owing to their dense population, urbanization and location along river estuaries and low-lying coastal plains. These findings underline the heightened exposure of Goa's socio-economic hubs to climate-induced hazards. In addition, sea-level rise data, though limited primarily to the Mormugao tide gauge, indicates a rising trend of about 1.45 mm per year,

reinforcing the urgency of coastal zone management and adaptation planning.

The plan also emphasizes other aspects of vulnerability including soil erosion, saline water intrusion into aquifers and threats to critical ecosystems such as mangroves, wetlands and khazan lands. Such ecosystems not only sustain livelihoods but also act as natural buffers against extreme events. By highlighting these risks, the SAPCC makes a strong case for ecosystem-based adaptation strategies.

Despite these strengths, the reliance on coarse-resolution global climate models limits the precision of local projections. Downscaled, high-resolution climate modeling tailored specifically to Goa's microclimates would greatly improve the robustness of vulnerability assessments. Moreover, while the SAPCC identifies vulnerable populations, the analysis remains broad and descriptive, lacking integration of socio-economic indices such as gender, caste, income and occupation that influence adaptive capacity.

Overall, the integration of climate science and vulnerability mapping represents a key achievement of the SAPCC, providing evidence-based direction for policy formulation. However, the State must strengthen its scientific base through localized modeling, expanding tide-gauge networks, satellite-based monitoring and composite vulnerability indices to ensure that climate policies are precise, inclusive and actionable.

4. Comprehensive Sectoral Strategies

The Goa SAPCC provides a multi-sectoral framework that integrates both mitigation and adaptation measures, reflecting the interconnected nature of climate challenges. The strategies are designed to mainstream climate action into the State's development planning, covering energy, transport, waste, water, agriculture, fisheries, forests, biodiversity, tourism and mining.

Mitigation Strategies: The mitigation component focuses on reducing greenhouse gas emissions through a combination of renewable energy deployment, energy efficiency, clean transport and sustainable waste management. Goa, being heavily dependent on imported electricity from the national grid, has emphasized tapping into its solar energy potential. The SAPCC sets a target of enhancing renewable energy capacity, particularly rooftop solar, to reduce reliance on fossil fuels. The plan also advocates a transition to electric mobility, with policy measures to promote electric vehicles, establish charging infrastructure and incentivize cleaner public transport. Waste management is another area of focus, with proposals for waste segregation, composting, recycling and exploring waste-to-energy technologies. Agriculture-related mitigation strategies include promoting organic farming, reducing chemical fertilizer dependence and encouraging climate-smart practices that lower methane and nitrous oxide emissions.

Adaptation Strategies: Adaptation is treated as a central pillar of the SAPCC, given Goa's vulnerability to coastal and inland climate risks. In the water sector, strategies include rainwater harvesting, watershed management, restoration of traditional tanks and promoting efficient irrigation methods like drip and sprinkler systems. Agriculture adaptation measures emphasize crop diversification, drought- and flood-resistant crop varieties, soil conservation and capacity-building for farmers. In fisheries, the plan highlights sustainable aquaculture practices, protection of breeding grounds and measures to offset the risks posed by ocean acidification and warming seas. The health sector is addressed through surveillance systems for climate-sensitive diseases, public awareness campaigns and strengthening health infrastructure to cope with emerging vector-borne diseases.

Forests and biodiversity are recognized as vital for both mitigation and adaptation. The SAPCC underscores the role of mangroves, wetlands and khazan lands in providing natural barriers against sea-level rise and flooding. It proposes afforestation and reforestation programs, protection of biodiversity heritage sites and community-led conservation initiatives. Tourism and mining two sectors central to Goa's economy are also considered. For tourism, the plan suggests promoting eco-tourism, regulating coastal development and adopting green certification systems for hotels and resorts. In mining, strategies include scientific reclamation of degraded sites, restoration of biodiversity in mined-out areas and monitoring of pollution levels.

Cross-cutting Strategies: The plan also emphasizes education, research and capacity-building as cross-sectoral enablers. Climate change awareness campaigns, integration of climate issues into curricula and strengthening research in local universities are highlighted as essential tools to sustain long-term action. Furthermore, disaster risk reduction strategies such as strengthening early warning systems, improving cyclone shelters and training local communities are integrated into the sectoral framework.

Overall, the sectoral strategies reflect a comprehensive vision that balances development needs with environmental imperatives. However, many of these strategies remain at the level of broad recommendations, lacking specific timelines, quantifiable targets and monitoring indicators. Strengthening these aspects will be crucial for ensuring that the strategies move beyond policy rhetoric into measurable action.

Financial Estimates: The financial framework outlined in the Goa SAPCC (2023–2033) is estimated at ₹2341 crore over a ten-year period, which equates to roughly 1.1% of the State's annual budget. This allocation is intended to cover a wide array of sectoral interventions, spanning energy

transition, ecosystem restoration, agriculture, water management, health and capacity-building. The plan underscores the importance of financial planning as a backbone for successful implementation of climate strategies.

Budgetary Allocation and Sectoral Distribution: While the SAPCC gives an overall budget estimate of ₹2341 crore, it does not spell out how this amount will be divided across different sectors. Areas like renewable energy, water conservation, agriculture and health are likely to take up a large share, but the lack of precise figures makes it difficult to judge whether the funding is adequate for the challenges each sector faces. For instance, moving towards electric mobility or expanding rooftop solar on a large scale will demand far greater investments than what the consolidated figure suggests.

Innovative Financing Mechanisms: The SAPCC puts forward innovative approaches to raise resources including green taxes on tourism, revolving funds and support for climate-resilient enterprises. These measures acknowledge that the State's climate goals cannot be achieved through regular budget allocations alone. Given Goa's heavy reliance on tourism, a green cess is especially relevant as it follows the "polluter pays" principle while generating a steady stream of funds for environmental protection. In the same way, revolving funds for renewable energy or waste-to-energy initiatives can create long-term financial stability, with profits from earlier projects being reinvested into new ones.

Challenges in Financial Mobilisation: Despite these proposals, the SAPCC does not fully articulate pathways for tapping into external finance such as the Green Climate Fund, Adaptation Fund, or bilateral and multilateral climate finance sources. The lack of a clear roadmap for attracting private investment, issuing green bonds, or mobilising corporate social responsibility (CSR) funds remains a weakness. Moreover, the plan does not address mechanisms for leveraging public–private partnerships (PPP) in a systematic way, which could otherwise enhance investment flows into sectors such as renewable energy, infrastructure resilience and eco-tourism.

Adequacy and Transparency: Given the scale of climate risks outlined in the SAPCC, the allocation of ~₹234 crore annually appears modest. Achieving transformative outcomes in renewable energy, electric mobility, health infrastructure and biodiversity protection will likely require significantly greater investment. Furthermore, the SAPCC provides limited clarity on accountability mechanisms for financial disbursement, monitoring and impact evaluation. Transparent financial tracking, coupled with periodic audits, will be crucial to ensure that allocated resources are used effectively and that funds reach vulnerable communities. In summary, while the SAPCC deserves credit for proposing a consolidated financial estimate and recognizing innovative funding tools, its framework remains underdeveloped in terms of sectoral clarity, external financing strategies and transparency mechanisms. Strengthening this financial architecture will be essential to translate Goa's climate vision into measurable and lasting outcomes.

Institutional Framework: The establishment of a State Climate Change Cell under the Department of Environment provides a nodal agency for coordination, with annual reviews by the Governing Council headed by the Chief Minister.

Gaps in the Goa SAPCC

1. Data and Scientific Limitations: While the SAPCC has made use of IMD and NCPOR data alongside global climate models, the scientific foundation remains limited in scope and precision. The absence of downscaled, high-resolution climate projections for Goa restricts the ability to capture micro-level variations in rainfall, temperature and sea-level rise. Reliance on a single tide gauge at Mormugao for sea-level monitoring undermines the robustness of coastal vulnerability assessments. Furthermore, socio-economic data integration is insufficient, with little disaggregation by gender, caste, occupation, or income levels that influence adaptive capacity. The vulnerability assessments are largely descriptive and lack composite indices that combine ecological, infrastructural and demographic factors.

2. Weak Mitigation Targets: Although the SAPCC endorses renewable energy, the target of 300 MW by 2030 is modest given Goa's estimated solar potential of over 1,000 MW. The electric mobility strategy lacks specificity, providing no concrete targets for the number of EVs, charging stations, or timelines for public fleet transition. Industrial emissions and energy efficiency measures are addressed broadly without sector-specific roadmaps. Moreover, blue carbon strategies such as systematic restoration of mangroves, seagrasses and coastal wetlands are mentioned but not developed into actionable targets, despite Goa's extensive coastline and estuarine systems.

3. Gaps in Adaptation Strategies: Adaptation measures look good on paper, but when they are put into action, they show that there are certain gaps in different areas. For example, in the health sector, more needs to be done to deal with climate-sensitive diseases like dengue, malaria and Kyasanur Forest Disease (KFD), which are still big problems in Goa. Social factors such as migration, changes in livelihoods and community vulnerability need further attention, especially because some coastal communities are already being forced to move because of erosion and flooding. Urban adaptation projects, while promising, frequently lack specificity and might gain from enhanced integration with land-use planning, housing regulations and smart city initiatives.

Likewise, policies for agriculture and fisheries provide valuable guidance but lack concrete plans for action,

particularly in providing targeted assistance to small farmers and traditional fishing communities that are most vulnerable to climate change.

4. Financing Challenges: The financial estimates of ₹2341 crore over ten years equate to a modest annual allocation relative to the magnitude of climate risks. While the SAPCC proposes innovative ideas such as green taxes and revolving funds, there is no roadmap for mobilising global climate finance through the Green Climate Fund, Adaptation Fund, or bilateral partnerships. The absence of strategies for green bonds, climate insurance, or carbon markets limits diversification of funding sources. Private sector engagement and PPP models are mentioned only in passing, leaving uncertainty about how to unlock larger pools of investment for renewable energy, resilient infrastructure and ecosystem restoration.

5. Institutional and Monitoring Weaknesses: Institutional arrangements remain underdeveloped. The creation of a State Climate Change Cell and a governing council is a step forward, but monitoring mechanisms are vague and largely process-oriented. But for now, monitoring systems are primarily focused on processes and do not have clear, measurable indicators, which makes it hard to judge progress accurately. Working together with many Government entities also raises the danger of duplication, which could hold down implementation. However, monitoring systems at present are more process-oriented and lack clear, measurable indicators, which make it challenging to evaluate progress effectively. There is also more room for the community to be involved in measuring progress, especially because the SAPCC was written with a focus on participatory methods.

Future Directives

1. Strengthening Climate Science and Data: To build a more robust scientific foundation, Goa must invest in high-resolution, downscaled climate modeling that captures micro-level variations in rainfall, temperature and extreme events. To make climate projections that are more accurate for specific areas, partnerships with IMD, NCPOR, NIO and local colleges such as Government College, Borda-Margao, Goa (Autonomous) and Universities, should be strengthened. Coastal monitoring should go beyond just the Mormugao tide gauge. More stations should be set up throughout estuaries and beaches and satellite-based remote sensing should be used to help. A State-level climate data observatory can serve as a central repository for real-time climate and socio-economic information. Developing composite vulnerability indices that integrate ecological, infrastructural and demographic data including gender, caste and income, would enable more nuanced decision-making.

2. Enhancing Mitigation Ambition: Goa must raise its renewable energy target beyond 300 MW by 2030, aligning it with the State's actual solar and offshore wind potential. A phased roadmap for electric vehicle adoption should be created, with milestones for EV penetration, charging station deployment and public fleet electrification. The industrial sector requires sector-specific emission reduction pathways with benchmarks for energy efficiency and cleaner production technologies. Blue carbon ecosystems such as mangroves, seagrasses and wetlands should be systematically restored and monitored to act as long-term carbon sinks. Embedding circular economy principles in mining, construction and waste management can further reduce emissions while creating green jobs.

3. Deepening Adaptation Strategies: Adaptation must be more deeply embedded into health, agriculture, fisheries and urban systems. Health adaptation should include climate-smart disease surveillance, heat action plans and resilient health infrastructure in vulnerable talukas. Urban adaptation requires integrating climate resilience into land-use zoning, building codes, drainage systems and smart city initiatives. Agriculture should move towards agro-ecological approaches, with subsidies and training for drought-tolerant and flood-resistant crop varieties, coupled with irrigation efficiency programs. Fisheries must incorporate ocean-climate data, promote sustainable aquaculture and protect coastal breeding habitats. Blue carbon initiatives should be scaled up as both adaptation and mitigation measures. Migration-sensitive policies are needed to protect displaced communities and provide alternative livelihoods.

4. Securing Climate Finance: A comprehensive climate finance roadmap is essential to diversify funding sources. Goa should actively pursue international climate finance through the Green Climate Fund, Adaptation Fund and bilateral partnerships. State-level green bonds and climate insurance products can mobilize domestic investors while protecting vulnerable groups against climate shocks. The State can leverage CSR contributions and design incentive structures to attract private investment in renewable energy, resilient infrastructure and eco-tourism. Strengthening PPP frameworks will be crucial in scaling up climate-smart transport, solid waste management and ecosystem restoration projects. Transparent financial tracking systems and independent audits should accompany these mechanisms.

5. Institutional Reforms: Reforms in Goa's climate governance need to move beyond the creation of a climate change cell. What the State requires, is an independent Goa Climate Change Commission with legal authority to guide implementation, track results and ensure accountability. Every sectoral plan should include SMART indicators specific, measurable, achievable, relevant and time-bound to make it possible to monitor progress effectively. Stronger coordination between departments is also essential and this can be achieved through joint task forces that bring together transport, energy, tourism and agriculture policies under a shared climate framework. Transparency should be enhanced through digital platforms that allow citizens to follow progress, share feedback and actively engage in climate initiatives. At the same time, community-led

monitoring, supported by biodiversity management committees and local panchayats, can build accountability from the ground up.

Conclusion

The Goa State Action Plan on Climate Change (2023–2033)[6] marks an important step in shaping the State's response to climate challenges. It draws strength from its inclusive approach to planning, its consistency with national and international frameworks and the breadth of issues it addresses across different sectors. However, with stronger scientific data, better funding support, enhanced institutional capacity and more ambitious goal-setting, its effectiveness could be significantly improved.

For Goa to emerge as a leading coastal State in building climate resilience, it will need to adopt more rigorous scientific approaches, raise the level of ambition in both mitigation and adaptation, secure long-term financial support and ensure stronger institutional accountability. By moving in this direction, Goa has the potential to inspire other states and small coastal regions around the world.

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