iFOREST | INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

माझी वसुंधरा

RATNAGIRI DISTRICT DEVELOPMENT-CUM-CLIMATE ACTION PLAN

BUILDING A CARBON-NEUTRAL AND CLIMATE-RESILIENT FUTURE

Ratnagiri District Development-cum-Climate Action Plan

Building a Carbon-Neutral and Climate-Resilient Future

iFOREST
INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

Research Direction: Dr. Chandra Bhushan

Research and writing: Dr. Sindhuja Kasthala, Aradhya Prasad and Dhwani Shah

Research Support: Deepak Singh Rathore and Meet Makwana

Layout: Dhwani Shah

December 2025

Citation: Ratnagiri District Development cum Climate Action Plan. International Forum for Environment, Sustainability and Technology (iFOREST). New Delhi, India.

Contents

List of Tables

List of Figures

List of Maps

List of Abbreviations

AF	Adaptation Fund
AR6	Sixth Assessment Report
BMCs	Biodiversity Management Committees
CAMPA	Compensatory Afforestation Fund Management & Planning Authority
C&D	Construction and Demolition
C&I	Commercial and Industrial
CETP	Common Effluent Treatment Plant
CMIP	Coupled Model Intercomparison Project
CO_2 / CO_2e	Carbon Dioxide / Carbon Dioxide Equivalent
CROPSAP	Crop Pest Surveillance and Advisory Project
CSR	Corporate Social Responsibility
CVI	Coastal Vulnerability Index
DCC	District Climate Cell
DCFP	District Climate Finance Platform
DCR	Domestic Content Requirement
DPC	District Planning Committee
DDMP	District Disaster Management Plan
DDUGJY	Deendayal Upadhyaya Gram Jyoti Yojana
ECSBC	Energy Conservation and Sustainable Building Code
Eco-DRR	Ecosystem-Based Disaster Risk Reduction
EOI	Expression of Interest
EV	Electric Vehicle
FAME	Faster Adoption & Manufacturing of Electric Vehicles
FPOs	Farmer Producer Organisations
GCF	Green Climate Fund
GDDP	Gross District Domestic Product
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GJ	Gigajoule
GRIDCO	Grid Corporation of Odisha
GSDP	Gross State Domestic Product

GW	Gigawatt
Ha	Hectare
HORTSAP	Horticultural Crop Pest Surveillance and Advisory Project
ICZM	Integrated Coastal Zone Management Programme
IPCC	Intergovernmental Panel on Climate Change
JFMCs	Joint Forest Management Committees
kWh	Kilowatt Hour
KVK	Krishi Vigyan Kendra
LPG	Liquefied Petroleum Gas
LULC	Land Use Land Cover
M&E	Monitoring and Evaluation
MDBs	Multilateral Development Banks
MEDA	Maharashtra Energy Development Agency
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MIDH	Mission for Integrated Development of Horticulture
MRV	Measurement, Reporting and Verification
MSME	Micro, Small & Medium Enterprises
$MtCO_2e$	Million Tonnes Carbon Dioxide Equivalent
MW	Megawatt
NABARD	National Bank for Agriculture and Rural Development
NAFCC	National Adaptation Fund for Climate Change
NDC	Nationally Determined Contributions
NICRA	National Initiative on Climate Resilient Agriculture
NMSA	National Mission for Sustainable Agriculture
OREDA	Odisha Renewable Energy Development Agency
OSF	Ocean State Forecast
PBRs	People's Biodiversity Registers
PCA	Principal Component Analysis
PES	Payments for Ecosystem Services
PKVY	Paramparagat Krishi Vikas Yojana
PM FME	PM Formalisation of Micro Food Processing Enterprises
PM KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PMMSY	Pradhan Mantri Matsya Sampada Yojana
PPP	Public–Private Partnership

PWD	Public Works Department
RCP	Representative Concentration Pathway
RE	Renewable Energy
RENA	Renewable Energy Agency of Odisha
RIDF	Rural Infrastructure Development Fund
RGPPL	Ratnagiri Gas and Power Private Limited
SAPCC	State Action Plan on Climate Change
SC/ST	Scheduled Castes / Scheduled Tribes
SHGs	Self-Help Groups
SSP	Shared Socioeconomic Pathway
SST	Sea Surface Temperature
ULBs	Urban Local Bodies

Executive Summary

Ratnagiri is a coastal district in Maharashtra characterised by a population of 1.6 million (84% rural) and rich natural assets. Its landscape spans the Western Ghats highlands and a 167 km Konkan coastline, dotted with mangrove-fringed creeks and wetlands that support fisheries, flood regulation, and biodiversity. The district is renowned for high-value horticulture – notably Alphonso mangoes, cashews, coconuts – alongside paddy cultivation. Major ports at Jaigad, Dabhol, and Ratnagiri anchor a vibrant coastal economy of fisheries and trade. Despite its natural wealth, the terrain (steep slopes, lateritic soils) renders many areas physically vulnerable to landslides, erosion and extreme rainfall, underlining the interdependence of development and environment.

Economically, Ratnagiri's Gross District Domestic Product (GDDP) stood at ₹28,483 crore in 2023–24, growing at 3.6% annually (slower than the state average of 4.5%). The economy has a strong natural resource base, with agriculture, horticulture, livestock, fisheries, forestry and mining comprising 19% of output. Industry (manufacturing, energy, construction, ports) contributes 25%, while services dominate at 56% (led by trade, transport, tourism, finance, public services). Per capita income remains below the state average (₹1.6 lakh vs ₹1.9 lakh), reflecting modest growth. Nonetheless, the district's Strategic Development Plan 2023–24 envisions Ratnagiri as a model of inclusive, innovative, and sustainable growth, leveraging its coastal and forest ecosystems as core assets. The strategy aims for balanced economic expansion rooted in agriculture, fisheries, tourism and services (with catalytic industrial growth), targeting an ambitious 14.9% annual GDP growth to become a USD 13 billion economy by 2028. Climate change now emerges as a critical challenge to this vision – threatening farm productivity, fisheries, infrastructure, water resources and coastal settlements. Recognising this, the District Development-cum-Climate Action Plan integrates development priorities with climate adaptation, low-carbon growth, ecosystem management, and disaster risk reduction into a unified long-term framework. This plan provides a roadmap for Ratnagiri to pursue sustainable development while building resilience and carbon-neutral pathways in the face of climate risks.

A. District climate profile

Ratnagiri's climate exposure is increasing due to rising temperatures, intensifying monsoon rainfall, and sea-level rise. Mean temperatures have already increased by about 1°C since the 1970s, and projections suggest continued warming of 2.3–3.3°C by mid-century. Rainfall is expected to shift towards more frequent high-intensity downpours, raising the likelihood of flash floods and urban flooding. Along the coast, sea levels are rising at roughly 3 mm/year and could reach about 0.22 m by 2050, heightening risks of tidal flooding, saline intrusion, and higher storm surge impacts.

These trends translate into multi-hazard risks shaped by Ratnagiri's terrain and coastline. Steep slopes and lateritic soils increase landslide susceptibility across 167 villages, while narrow river valleys and low-lying floodplains amplify riverine flooding across 548 villages (nearly one-third of all villages) —with analysis indicating that flood-prone area could nearly double by 2050. Coastal stretches face increasing cyclone/coastal storm impacts, shoreline erosion, and damage to ports, fishing settlements, and backwater ecosystems. Critically, these hazards can overlap and cascade—intense rainfall can saturate slopes (triggering landslides) while simultaneously swelling rivers and flooding settlements.

Socio-economic vulnerabilities magnify climate impacts in specific pockets. While many villages may show relatively low overall vulnerability, clusters of higher vulnerability persist—linked to poverty, marginal landholdings, limited irrigation, dependence on agriculture/fisheries, and gender disparities—reducing adaptive capacity and recovery speed after shocks. Recent land-use change trends (e.g., increasing built-up area and infrastructure expansion) can increase exposure by reducing infiltration and natural drainage, adding pressure on wetlands/mangroves, and expanding settlement footprints into hazard-prone zones—making risk-informed land-use planning and ecosystem protection essential.

Ratnagiri's climate profile also includes its mitigation challenge and opportunity. District emissions are about 7.8 $MtCO_2e$/year, dominated by power, agriculture, and transport, with per-capita emissions higher than state/national averages. At the same time, Ratnagiri has substantial natural carbon sinks—forests, mangroves, wetlands, croplands and grasslands—sequestering roughly 1.0–1.8 $MtCO_2$/year, offsetting 10–20% of annual emissions. The district has strong potential to scale solar, distributed renewables, and clean energy for agriculture, cold chains, and coastal infrastructure, supporting both emissions reduction and resilience. Together, these realities justify a development pathway that simultaneously reduces emissions, strengthens resilience, and expands ecosystem-based protection.

B. Long-term strategic goals (2050)

To realise its development vision in a changing climate, Ratnagiri has defined four long-term strategic goals for 2050, which anchor this integrated Climate and Development Plan:

- **Carbon Neutrality by 2050:** Achieve net-zero carbon emissions growth, balancing emissions with carbon sinks, through clean energy, low-carbon infrastructure, and sustainable practices.
- **Climate Resilience:** Build robust adaptive capacity across communities, infrastructure, and ecosystems to withstand climate shocks (extreme weather, sea-level rise, etc.) and safeguard livelihoods and development gains.
- **Ecosystem-based Disaster Risk Reduction (Eco-DRR):** Substantially reduce vulnerability to climate-related disasters (floods, landslides, cyclones, etc.) through risk-informed planning, early warning systems, and resilient infrastructure & response mechanisms.

- **Ecosystem Conservation & Carbon Stewardship:** Protect and restore forests, mangroves, watersheds, and biodiversity while enhancing their carbon sequestration potential – recognising healthy ecosystems as natural infrastructure for climate mitigation and disaster risk reduction.

These four goals are interrelated and mutually reinforcing: achieving carbon neutrality will largely come via ecosystem stewardship and clean energy (mitigation), which also contributes to resilience; bolstering DRR and adaptation (resilience) safeguards the development needed to invest in mitigation. Together, they provide a holistic direction for Ratnagiri's sustainable future.

C. Key strategies under each goal

To translate the above goals into action, the plan outlines a comprehensive set of strategies and interventions. Major strategies under each goal are briefly given below:

Goal 1: Carbon neutrality by 2050

- Accelerated deployment of solar, wind, rooftop, floating, and agri-PV, supported by RE procurement reforms.
- Solarisation of agricultural feeders, cold chains, public buildings, and fisheries infrastructure.
- Low-carbon agriculture through regenerative practices, low-emission paddy, agroforestry, and biochar.
- Low-carbon transport transition through EV adoption (public fleets, freight, ports), charging infrastructure, and fuel-efficient fishing and logistics fleets.
- Industrial energy efficiency, MSME RE aggregation, and waste-to-energy from horticulture and fisheries residues.
- Green buildings through ECBC-compliant design, cool roofs, and energy-efficient building systems and technology upgrades.

Goal 2: Climate resilience

Resilience strategies focus on strengthening agriculture, coastal livelihoods, and climate-resilient infrastructure:

- Climate-resilient agriculture, including micro-irrigation, climate-tolerant crop varieties, crop diversification, slope stabilisation, and watershed restoration.
- Climate-resilient fisheries and coastal livelihoods, supported by safer and upgraded landing centres and harbours, improved navigation systems, early-warning dissemination, and renewable-powered drying and cold-chain units.

- Resilient infrastructure, with climate-informed design standards, improvements to drainage and stormwater systems, and integration of climate considerations into urban and rural development planning.

Goal 3: Ecosystem-based Disaster Risk Reduction (Eco-DRR)

A strengthened DRR system supports the district's climate resilience through:

- Risk-informed land-use zoning and infrastructure planning, integrating flood modelling, landslide-susceptibility maps, and coastal vulnerability assessments.
- Eco-DRR measures, using mangroves, wetlands, backwaters, and river buffers as natural barriers to reduce flood, erosion, and coastal risks.
- Climate-safe housing and basic infrastructure facilities, including slope stabilisation, improved drainage, multi-hazard shelters, and upgrading infrastructure and houses in high-risk villages.
- Designation of no-go areas in locations with unmitigable hazard exposure.

Goal 4: Ecosystem conservation & carbon stewardship

Ratnagiri's forests, mangroves, estuaries, and riparian systems are vital for carbon storage and risk mitigation. Key actions include:

- Mangrove and wetland restoration, designation of eco-DRR zones, and conservation of coastal dunes.
- District-wide agroforestry expansion and regeneration of degraded forests.
- Sustainable eco-tourism and zero-waste forest economies, promoting low-carbon tourism, Green/Zero-Waste certification, decentralised waste management in forest villages, and elimination of single-use plastics through nature-based alternatives.
- Exploring carbon-market opportunities to incentivise community stewardship.

These strategic pathways for mitigation, adaptation, ecosystem management, and DRR are mutually supportive. Together, they chart a course for Ratnagiri to achieve its four district goals by 2050 – moving toward a low-carbon, climate-resilient, and sustainable development paradigm.

D. Short-term priority interventions (2026–2030)

While the long-term vision extends to 2050, the plan prioritises immediate actions in the next 4 years (2026–2030) to kick-start the transition. Key priority interventions across sectors include:

Agriculture & Horticulture:

- Expand micro-irrigation (5,000 ha), farm ponds, and solar-powered irrigation.
- Promote climate-resilient seeds (salt-, drought-, heat-tolerant) and distribute seed kits to 45,000 farmers.
- Diversify cropping through double cropping, intercropping (2,000 ha), and pulses/spices in coconut & mango orchards.
- Rejuvenate old mango orchards with pruning, grafting, climate-tolerant varieties, and adaptive heat-resilient practices.
- Introduce pest/disease forecasting and conduct research on heat impacts on flowering.
- Build post-harvest resilience via solar-powered cold storage, packhouses, climate-controlled ripening chambers, and low-carbon packaging.
- Reduce post-harvest losses with improved grading, packaging, climate-ready chambers.
- Expand community seed banks and R&D for climate-resilient varieties.
- Promote soil-moisture conservation (mulching, shade crops), micro-irrigation for intercrops, and rainwater harvesting.
- Develop climate-resilient fallow land through hardy crops and Agro-PV pilots.
- Build farmer capacity on climate-smart orchard management.

Energy

- Install 500 MW solar capacity by 2030 and rooftop solar (10 MW) with battery storage on public buildings.
- Deploy 3,000 solar pumps and solar streetlights in 50% of villages. Roll out district-wide LED adoption and smart meters.
- Strengthen grid resilience via underground cabling, resilient poles, and solar-battery systems for health facilities.
- Conduct techno-economic repurposing of the gas-based power plant for RE/ hydrogen/ industrial use.

Fisheries

- Deploy 50 cyclone-resilient open-sea fish cages and establish a climate-smart shrimp hatchery.

- Promote climate-resilient aquaculture (RAS, temperature-controlled systems, improved aeration).
- Modernise fishing vessels with fuel-efficient engines, safety kits, early-warning devices, and GPS (100% coverage).
- Strengthen cold chain through solar-powered ice plants, cold rooms, and improved fish handling infrastructure.
- Diversify livelihoods (eco-tourism, ornamental fish culture, value-added products).
- Implement sea ranching with habitat restoration (mangroves, coral areas).
- Pilot low-carbon deep-sea fishing (hybrid propulsion).

Buildings & Infrastructure

- Apply climate-resilient building codes to all new government buildings; retrofit critical facilities (schools, hospitals).
- Promote green buildings with rooftop solar and rainwater harvesting.
- Climate-proof roads and bridges using elevated embankments, improved drainage, erosion-resistant design, and vegetation-lined corridors.
- Install EV charging points at 5 major locations.
- Expand urban flood management via stormwater drains, mangrove restoration, and urban wetland pilots.
- Upgrade climate-resilient rural footbridges and strengthen bridges to withstand higher flood flows and scouring.

Industry & MSMEs

- Promote renewable energy and energy efficiency in MSMEs; install 10 MW industrial solar/biomass.
- Develop a pilot Green Industrial Zone with shared RE and resilient infrastructure.
- Build green skills among 5,000 youth and integrate clean-tech training.
- Strengthen industrial climate risk planning and emergency response.
- Integrate climate-smart entrepreneurship into PMEGP and other schemes.

Tourism

- Promote eco-tourism with conservation-based nature trails, farm tourism, and plastic-free tourist zones.
- Construct climate-smart beach facilities (elevated shacks, waste management systems) and protect sensitive coastal ecosystems.
- Build resilient tourism infrastructure powered by renewable energy and improved drainage.

To operationalise these pathways, the Plan proposes strong institutional and financial enablers to ensure coordinated implementation and sustained impact. A District Climate Cell (DCC) will be established within the district administration as the nodal institutional mechanism for climate governance. The DCC will coordinate across line departments, integrate climate priorities into annual district planning and budgeting processes, support data-driven decision-making, and track progress on mitigation, adaptation, ecosystem management, and disaster risk reduction actions. By anchoring climate action within district institutions, the DCC will help mainstream climate considerations across sectors rather than treating them as standalone initiatives.

Complementing this, the Plan proposes a District Climate Finance Platform (DCFP) to mobilise and channel financing for priority climate and development interventions. The DCFP will support convergence of district, state, and central government schemes, leverage private investment and CSR resources, and explore climate-finance instruments, including carbon-market opportunities. The proposed carbon aggregator function will enable bundling of mitigation and ecosystem-based actions—such as agroforestry, biochar, mangrove restoration, and renewable energy—into scalable, finance-ready projects that can generate long-term revenue streams while strengthening ecosystem stewardship.

Together, the DCC and DCFP provide the institutional backbone required to translate the Plan's long-term vision into on-ground outcomes. They are designed to enhance coordination, improve financial sustainability, and ensure that climate action is embedded within routine governance and development delivery systems at the district level.

Overall, the Integrated District Development-cum-Climate Action Plan offers Ratnagiri a coherent and actionable roadmap to achieve its four long-term district goals. By aligning climate resilience, low-carbon growth, ecosystem conservation, and disaster risk reduction with development priorities—and by sequencing ambitious long-term strategies with clearly defined near-term actions—the district is well positioned to pursue sustainable and inclusive growth while safeguarding its people, economy, and ecological systems in the face of a changing climate.

Chapter 1: District profile

Ratnagiri, located along Maharashtra's Konkan coast, is characterised by its 167 km shoreline, rugged Western Ghats, fertile river valleys, and rich biodiversity. It has dense forests, mangroves, estuaries, fertile agricultural lands, lateritic plateaus, and a strong connection to both farming and the sea. Agriculture, horticulture, and fisheries form the backbone of its economy, and people here continue to depend on these sectors for their livelihoods. However, these climate-sensitive eco-systems are increasingly exposed to erratic monsoon, rising temperatures, and coastal hazards.[1]

1.1 District development profile

Administratively, Ratnagiri comprises nine tehsils — Mandangad, Dapoli, Khed, Chiplun, Guhagar, Sangameshwar, Ratnagiri, Lanja, and Rajapur. It includes 1,537 villages, 845 Gram Panchayats, five Nagar Panchayats, and four Municipal Councils. Ratnagiri town serves as the district headquarters and the main centre for administration.[2] Settlement patterns remain predominantly rural, but small urban centres such as Ratnagiri, Chiplun, and Dapoli function as service hubs for education, health, fisheries, and administrative activities.

Map 1: Ratnagiri district administrative boundaries and major urban centres

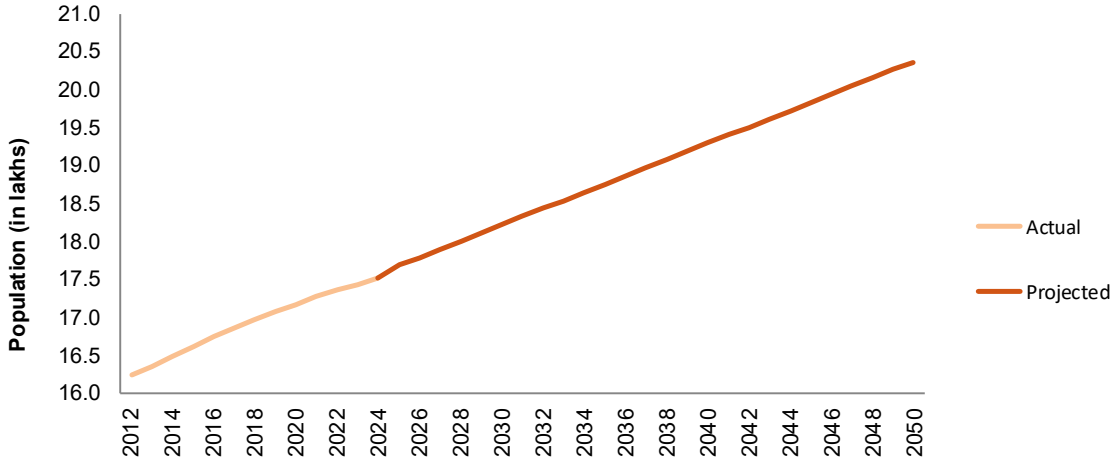
Source: iFOREST

1.1.1 Demographic and geographic overview

According to Census 2011, Ratnagiri has a population of 1.61 million, with nearly 84 percent living in rural areas. The district performs better than the state average on two key indicators — sex ratio of 1,122 and literacy rate of 82.18 percent. The district is well-known for its high-value horticulture, particularly Alphonso mangoes, cashews, and coconuts alongside paddy.[3]

The district's population has grown steadily over the past decade, increasing from about 1.62 million in 2012 to nearly 1.75 million in 2023. Using this historical trend, a linear projection suggests that the district will continue to experience stable and incremental population growth over the long term. The population is expected to exceed 1.8 million by 2030, continue its upward progression through the 2040s, and reach roughly 2.04 million by 2050. This long-range projection reflects a moderate but sustained demographic expansion, consistent with the district's historical growth pattern.

Figure 1: District population projection



Source: iFOREST analysis data based on the District Domestic Product Report 2023–24, Government of Maharashtra

Ratnagiri is also home to ecologically significant assets, including Western Ghats, mangroves, vast creek systems (Jaigad, Rajapur, Pawas), and several wetlands that support fisheries, flood regulation, and biodiversity. The district's ports—Jaigad, Dabhol, and Ratnagiri—support trade, energy infrastructure, and fisheries, linking the district to regional economic flows. Transport connectivity is supported by the Konkan Railway, National Highway corridors, and coastal roads, though many areas remain physically vulnerable due to steep slopes, soil erosion, and landslide risks.

Overall Ratnagiri's development is interconnected with it's natural environment. Its strong agricultural base, coastal economy, forest landscapes, and cultural heritage present

major opportunities for growth—but also underline the district's sensitivity to climate variability.

1.1.2 Economic overview

Ratnagiri's economy reflects a strong dependence on natural-resource-based sectors, supported by services and select industrial activities. For the year 2023-24, the tertiary sector forms the largest share of the district economy, followed by the secondary and primary sectors.[4]

- **Primary sector (₹47.9 billion; 19%)**
  Includes agriculture, horticulture, livestock, fisheries, forestry, mining, and quarrying. These sectors continue to be central to the district's livelihoods and are highly climate sensitive.

- **Secondary sector (₹63.7 billion; 25%)**
  Comprises manufacturing, construction, electricity, gas, water supply, and port-linked industrial activities. The sector includes food processing (cashew, mango), small-scale engineering, energy infrastructure, and ongoing industrial activity around Jaigad and Dabhol.

- **Tertiary sector (₹141.3 billion; 56%)**
  The largest contributor to GDDP, covering trade, transport, tourism, financial services, communication, real estate, public administration, and other services. Coastal tourism, port services, administrative, and commercial hubs in Ratnagiri, Chiplun, and Dapoli are key growth drivers.

Overall, Ratnagiri's Gross District Domestic Product increased from ₹238.8 billion in 2018–19 to ₹284.8 billion in 2023–24, demonstrating a modest cumulative annual growth rate of 3.6%, which is lower than Maharashtra's 4.5% growth over the same period. Similarly, Ratnagiri's per capita GDDP of ₹0.16 million, compared to Maharashtra's per capita GSDP of 0.19 million for 2023–24, is also substantially lower. This indicates that the district remains below the state average, reflecting relatively slower economic expansion.

1.1.3 Land use change and emerging development

Ratnagiri district is experiencing gradual structural shifts. While it remains predominantly rural, growing industrial activity, infrastructure development, and rising housing demand are contributing to changing land-use patterns.[5] An analysis of land use land cover (LULC) change between 2017 and 2024 reveals gradual but spatially uneven transformations influenced by development pressures, road connectivity, shifting land-use preferences, and ecological change (Annexure 1).

The district continues to be dominated by tree cover and rangelands, which together account for a major share of its landscape. However, significant changes are evident in built-up expansion and cropland decline, indicating emerging pressures on natural systems.

Table 1: District-Level LULC Change in Ratnagiri (2017–2024)

District	Class	Area (km²)			% Change	Trend
		2017	2024	Difference (2024-2017)		
Ratnagiri District	Water	168.4	167.1	-1.2	-0.7	Slight decline
	Trees	4,020	3,745.3	-274.8	-6.8	Moderate decline
	Flooded Vegetation	6.2	4.8	-1.4	-22.6	Sharp decline
	Cropland	138.2	119.5	-18.7	-13.5	Decline
	Built-up	195	405.6	210.7	108.1	Sharp increase
	Bare Ground	0.8	0.6	-0.1	-19.0	Decline
	Rangeland	3,763.2	3,848.8	85.6	2.3	Increase

Source: iFOREST analysis based on Impact observatory 2025

An assessment of taluka-level LULC changes shows the following trends:

- **Built-up:** Built-up areas expanded sharply across the district, with some talukas witnessing more than a 100% increase in seven years. Rajapur recorded the highest proportional increase (216.6 %), raising its built-up area from 8.4 km² to 26.7 km². Similarly, Khed, Chiplun, Dapoli, and Mandangad all saw their built-up footprints more than double.
- **Tree cover:** Tree cover reduction is consistent across the district. Khed lost about 88.9 km² (18.5 %) of its tree area, Chiplun shed 77.8 km² (13.5 %), and Dapoli declined by 26.9 km² (6.5 %). Ratnagiri and Lanja also saw moderate reductions in tree cover.
- **Croplands in most talukas:** Large declines were observed in Sangameshwar (–26.7%), Rajapur (–24.5%), Khed (–16.1%) and Mandangad (–15.6%). Only Lanja shows a notable increase (+12.6%), indicating an internal shift in agricultural land-use.
- **Water bodies:** While Rajapur and Sangameshwar recorded slight increases (around 1%), Khed, Lanja, and Ratnagiri show 3–5% decline.
- **Rangeland:** Rangelands expanded notably in Khed (+12.9%) and Chiplun (+10.3%), suggesting some conversion of other land types into open grazing or shrubland.

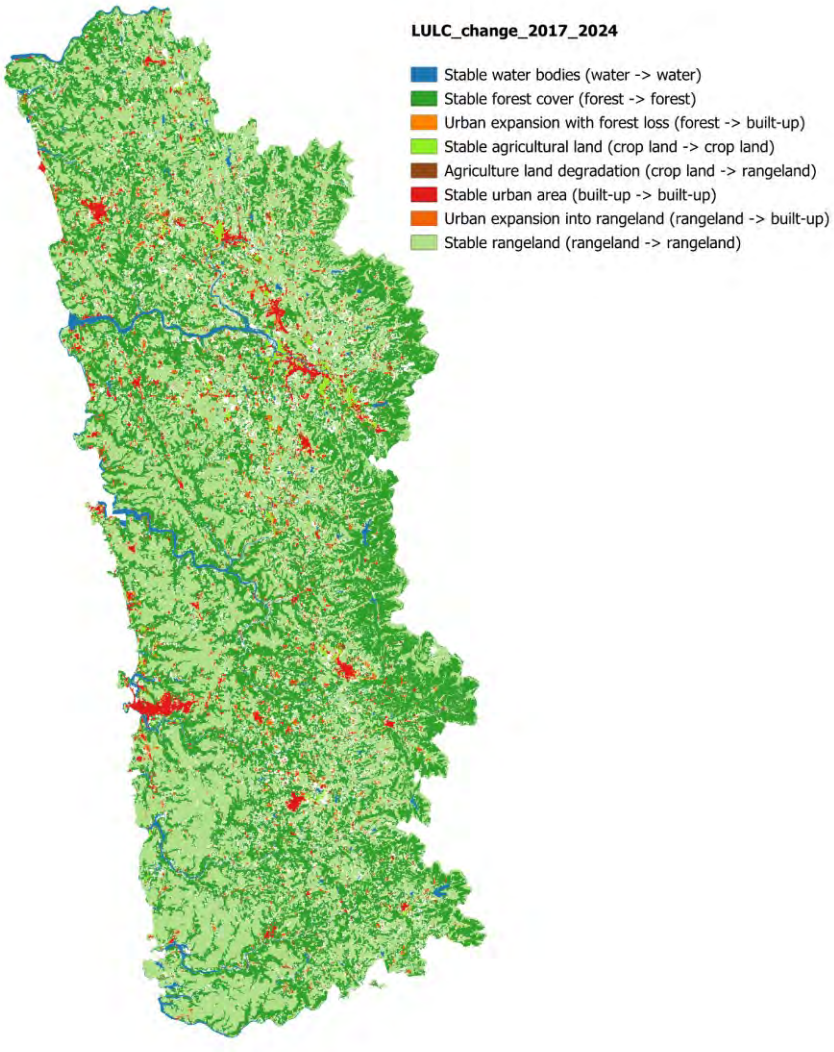
Thus, the LULC changes point to two major transitions:

(i) Rapid urbanisation and settlement expansion, signalling growing urban and peri-urban development and infrastructure growth

(ii) Increasing pressure on natural ecosystems, indicating ecological stress that may heighten climate risks across the district.

These shifts also influence where and how climate-resilient agriculture, ecosystem restoration, and low-carbon infrastructure strategies (detail in Chapter 2) will need to be prioritised.

Map 2: Land use land cover map of 2017 and 2024



Source: iFOREST analysis based on Impact observatory 2025

1.2 District climate profile

Ratnagiri's climate is shaped by its coastal–hilly geography, strong monsoon influence, and proximity to the Arabian Sea. Seasonal weather patterns are strongly influenced by the Western Ghats, resulting in high rainfall concentrations and distinct micro-climates across the district. This dynamic setting also heightens sensitivity to climate-related hazards such as extreme rainfall, landslides, coastal flooding, and shifts in temperature and humidity regimes.

1.2.1 Trends and projections

The climate projections in this assessment draw on datasets from the Coupled Model Intercomparison Project Phase 6 (CMIP6), which represents the most advanced ensemble of global climate simulations supporting the IPCC Sixth Assessment Report (AR6). CMIP6 employs the more comprehensive Shared Socioeconomic Pathways (SSPs) framework. SSPs link future socioeconomic development trajectories—such as population growth, technological change, governance, and energy transitions—with greenhouse gas concentration pathways, thereby providing more realistic and policy-relevant climate futures. Multiple CMIP6 datasets and models were used in this study depending on variable type, spatial resolution, and scenario availability.

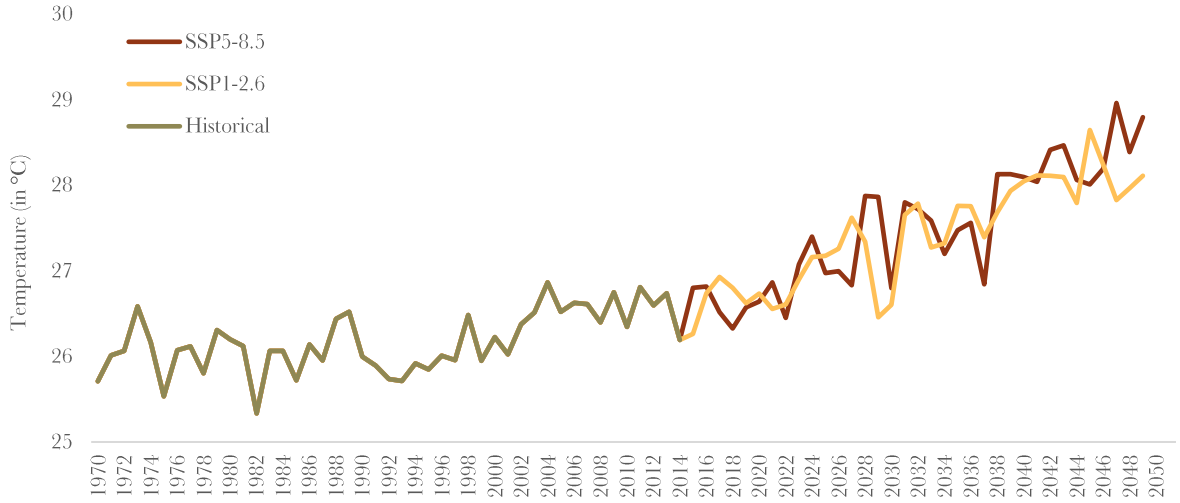
An analysis of historical trends and CMIP6 projections reveals clear warming, increasing precipitation variability, and rising risks linked to extreme weather. The following sections examine the key climatic variables that shape local weather, agriculture, hydrology, and coastal systems—surface temperature, maximum and minimum temperature, precipitation, windspeed, mean sea level and sea-surface temperature.

A. Temperature

Historical mean temperatures increased by nearly 1°C between the 1970s and 2015, rising from 25.7°C to 26.7°C. Projections under both low- and high-emission scenarios show continued warming:

- By 2035, mean temperatures are expected to reach 27.4–27.8°C, indicating a rapid warming of 0.7-1.1°C during 2015-2035. In other words, the projected warming from 2015 to 2035 (20 years) is of similar scale to that of warming experienced between 1970 to 2015 (45 years). The rate of warming has doubled.
- By 2050, SSP1-2.6 stabilises near 28°C, while SSP5-8.5 reaches 28.7–29°C, indicating 2.3–3.3°C warming since the 1970s.

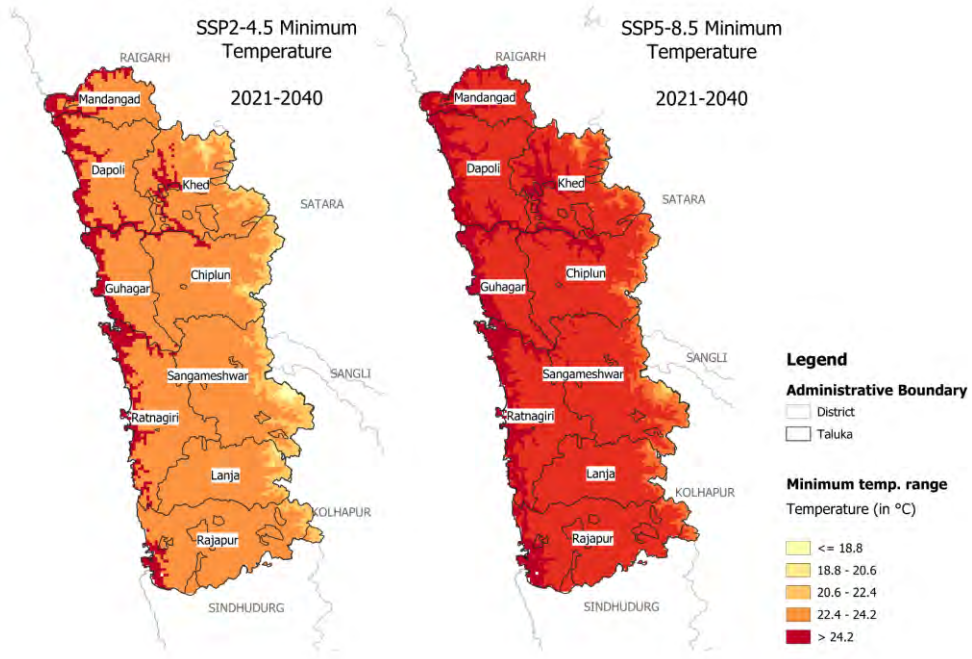
Figure 2: Historical and projected mean surface temperature trends (1970–2050)



Source: iFOREST analysis based on HadGEM3-GC31-MM, CMIP6 data (0.25° × 0.25°)

Projected minimum and maximum temperatures for 2021–2040 indicate a clear warming trend across Ratnagiri, with night-time temperatures rising particularly fast. Under SSP5-8.5, large parts of the district are projected to record minimum temperatures above 24°C, signalling reduced night-time cooling and a narrowing diurnal temperature range that may affect mango, cashew, and paddy physiology while increasing heat stress in coastal and urban settlements.

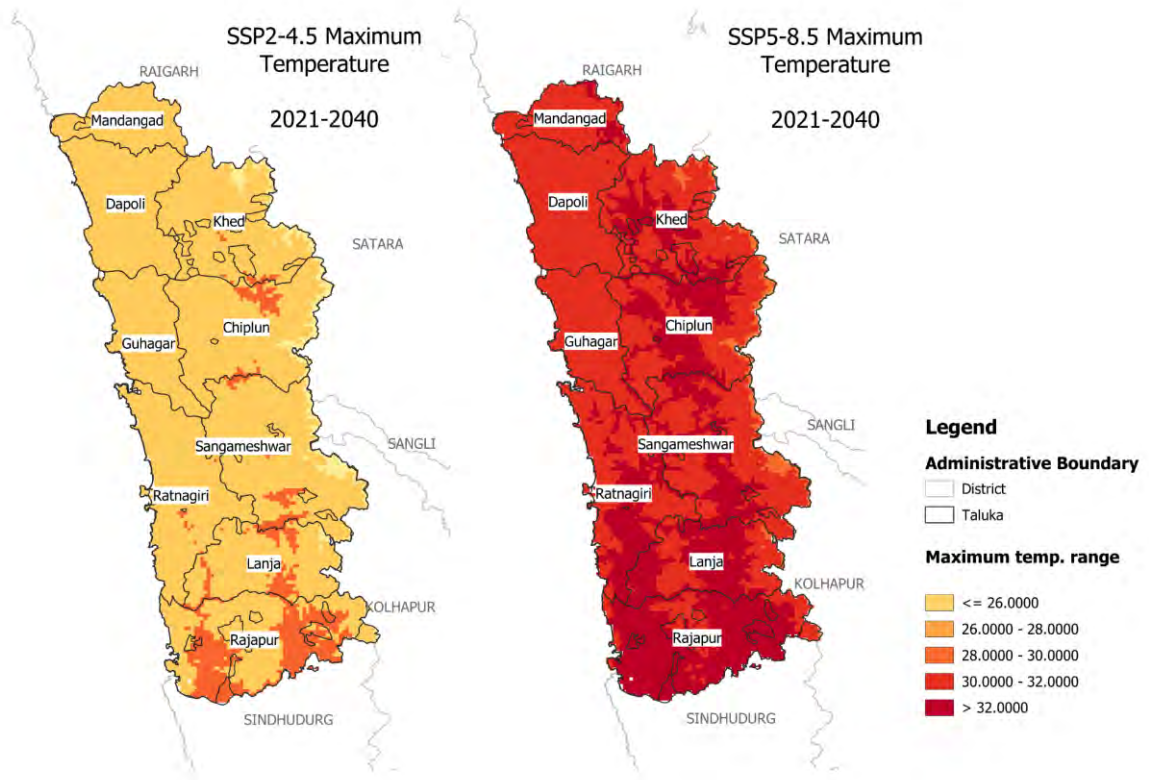
Map 3: Twenty-year average minimum temperature projections for Ratnagiri (2021–2040) under SSP scenarios



Source: iFOREST analysis based on HadGEM3-GC31-LL, CMIP6 data (0.008° x 0.008°)

Maximum temperatures (averaged over 20 years) follow a similar pattern, with interior talukas such as Rajapur, Lanja, and Sangameshwar exceeding 32°C, whereas coastal areas like Dapoli, Guhagar, and Mandangad remain relatively moderated by the sea. Yearly maximum temperatures—historically fluctuating between 37–39°C—are projected to cross the 39.5–40°C threshold more frequently by mid-century, particularly under SSP5-8.5. This points to greater heat stress for agriculture, livestock, and urban settlements. Together, these trends point to more frequent heat-stress conditions, higher crop-water and livestock water demands, increased energy use for cooling, and greater evapotranspiration—underscoring the need for heat action planning, micro-climate sensitive urban design, and climate-resilient agricultural practices.

Map 4: Twenty-Year average maximum temperature projections for Ratnagiri (2021–2040) under SSP scenarios



Source: iFOREST analysis based on HadGEM3-GC31-LL, CMIP6 data (0.008° x 0.008°)

B. Rainfall

Ratnagiri receives an average annual rainfall of about 3365 mm, primarily from the southwest monsoon, with the heaviest showers in July and August. Rainfall varies significantly across talukas, with the foothills of the Sahyadris experiencing exceptionally high rainfall, sometimes exceeding 450 mm in a single day, indicating a rise in climate-related extreme events.[6]

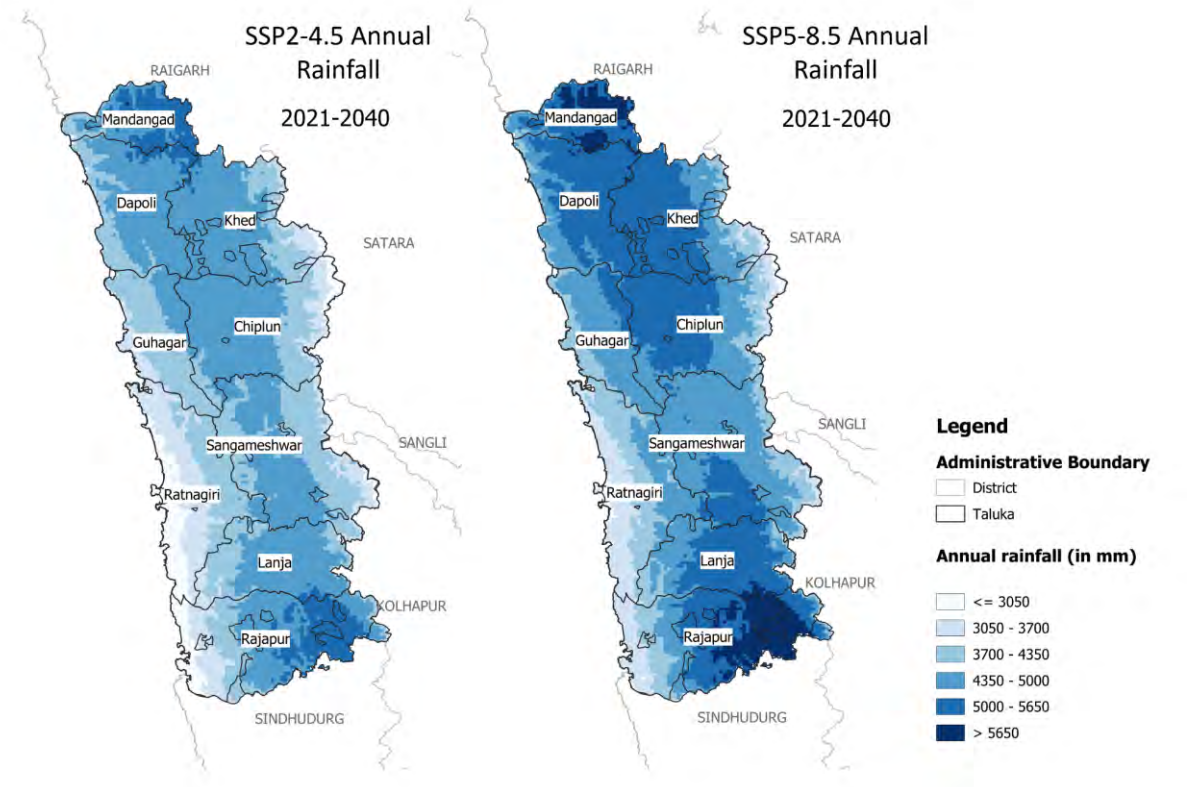
Figure 3: Historical rainfall pattern in Ratnagiri (1991–2024)

Source: Ratnagiri District Disaster Management Plan, 2024

Historical rainfall (1991–2024) shows substantial year-to-year variation, ranging from 5064 mm in 2012 to 2379 mm in 2015, while the long-term average of around 3364 mm remains relatively stable. The data indicates high variability but no discernible long-term trend over this period. However, when this historical baseline is compared with future 20-year average projections under SSP2–4.5 and SSP5–8.5, a clear shift emerges—both scenarios indicate a significant increase in mean monsoon rainfall across the district.[7]

In the future climate (2021–2040), spatial patterns of projected rainfall vary across the district. The northern talukas—Mandangad, Dapoli and Khed—are projected to receive higher rainfall totals of 4460–4930 mm under SSP2–4.5, increasing further to 4970–5490 mm under SSP5–8.5. Inland talukas such as Lanja, Sangameshwar and Chiplun also exhibit substantial increases, reaching 4200–4430 mm under SSP2–4.5 and 4700–5025 mm under SSP5–8.5. These projected increases heighten the risks of urban and riverine flooding, landslides, soil erosion and water-management pressures, particularly along the Western Ghats slopes, coastal zones and rapidly expanding urban centres.

Map 5: Yearly average rainfall projections for Ratnagiri (2021–2040) under SSP scenarios

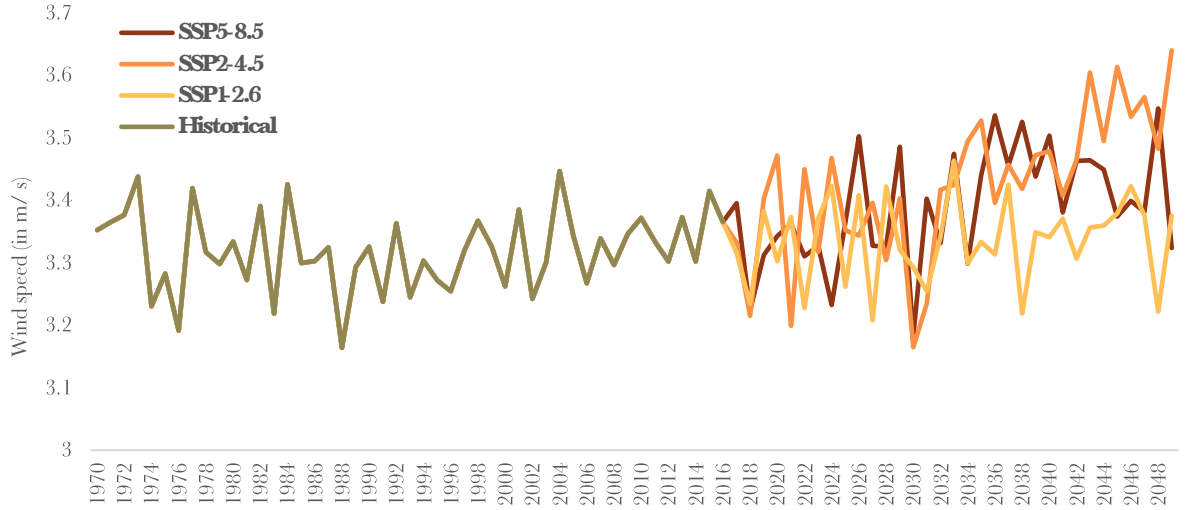


Source: iFOREST analysis based on HadGEM3-GC31-LL, CMIP6 data (0.008° x 0.008°)

C. Wind speed

Wind speeds in Ratnagiri have remained largely stable historically, with only a negligible increase of about +0.005 m/s per decade from 1970–2014. Future projections show a slight rise under SSP1-2.6 and a more pronounced strengthening under SSP5-8.5, driven by greater land–sea thermal contrasts. While the overall magnitude of change remains modest, even small increases in wind intensity may influence coastal erosion patterns, storm surge behaviour, and marine fishing safety, highlighting the need for strengthened early warning and harbour resilience.

Figure 4: Historical and projected windspeed trends for Ratnagiri (1970–2050)

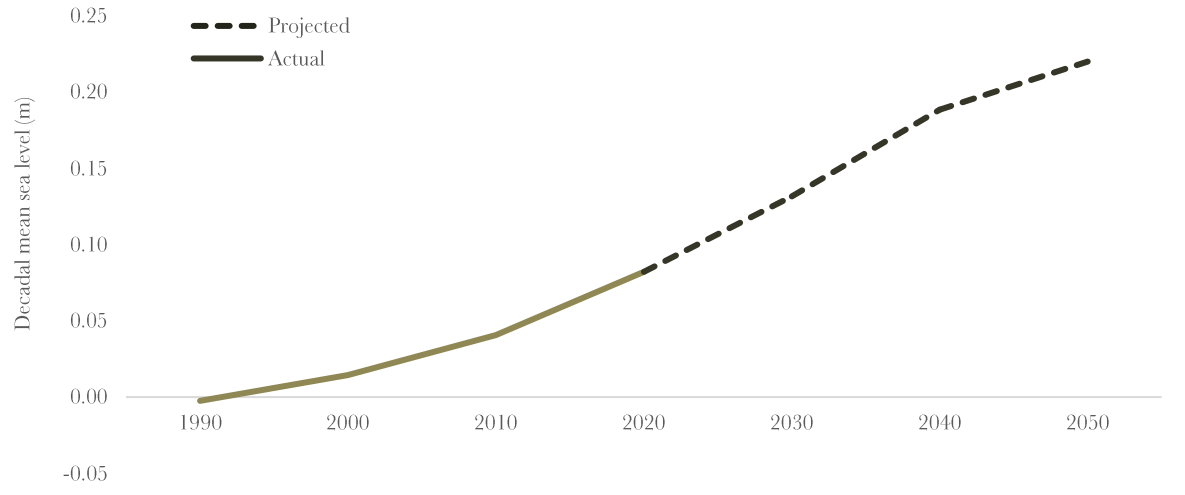


Source: iFOREST analysis based on FGOALS-g3 data

D. Mean sea level

Mean sea level along the Ratnagiri coast shows a steady rise of about +2.97 mm per year over the past five decades, closely matching global trends reported in IPCC AR6. Levels shift from slightly negative values in the 1970s to consistently positive after 2000, reaching a projected +0.22 m by 2050, indicating a total rise of nearly 24 cm since 1970. This sustained increase heightens risks of tidal flooding, saline intrusion, erosion, and high-water extremes, particularly for low-lying fishing settlements, estuarine agriculture, and port-linked infrastructure. Continued rise is expected through mid-century due to ocean thermal inertia, underscoring the need for long-term coastal adaptation planning.

Figure 5: Decadal mean sea level trend (1990-2050)

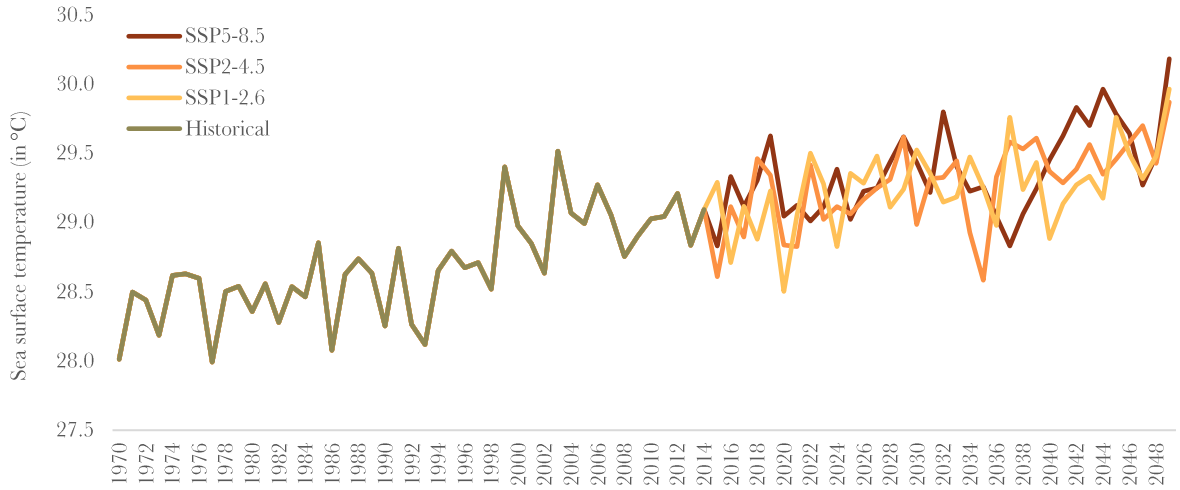


Source: iFOREST analysis based on data from Copernicus Climate Change Service (C3S) Climate Data Store (CDS)

E. Sea surface temperature

Sea surface temperature (SST) along the Ratnagiri coast shows a steady warming trend—about +0.19°C per decade historically, consistent with broader Arabian Sea warming. All future scenarios project continued increases, with several years under SSP5-8.5 likely to cross 30°C by the 2040s, signalling stronger ocean heat accumulation. Rising SSTs have major implications for fishery productivity, coastal ecosystems, monsoon behaviour, and marine heat-stress events, underscoring the vulnerability of coastal livelihoods and nearshore ecology.

Figure 6: Sea surface temperature trend SSP scenarios



Source: iFOREST analysis based on FGOALS-g3 data (0.9° x 0.9°)

1.2.2 Climate risks and vulnerabilities

Recent climate patterns in the district show a clear intensification of hazards, heavier short-duration rainfall, more frequent localised flooding, hotter pre-monsoon periods, and recurring landslides in hilly belts. These shifts do not act in isolation; they interact with existing settlement growth, ecological degradation, and infrastructure gaps, creating different levels of risk across talukas. Mapping these hazards, exposure, sensitivity linkages help identify where vulnerabilities are most concentrated and which communities, assets and sectors need priority attention for district-level resilience planning.

A. Hazard profile

Floods

Flooding is one of the most critical climate hazards in Ratnagiri, driven by intense monsoon rainfall, steep Western Ghats terrain, and a dense river network that funnels runoff toward the coast. Analysis of high-resolution CLIMADA riverine flood projections shows a clear intensification of flood hazard under future climate conditions. The total flood-prone area

nearly doubles, increasing from 1,071 km² historically to 1,978 km² under the RCP 6.0 (2030–2050) scenario.

The most significant expansion occurs in the 4–7 m flood-depth zone, indicating deeper and more prolonged inundation across river valleys and agricultural lowlands. These changes are reflected spatially in the flood maps, which show a widening and deepening of inundation bands across the district over time.

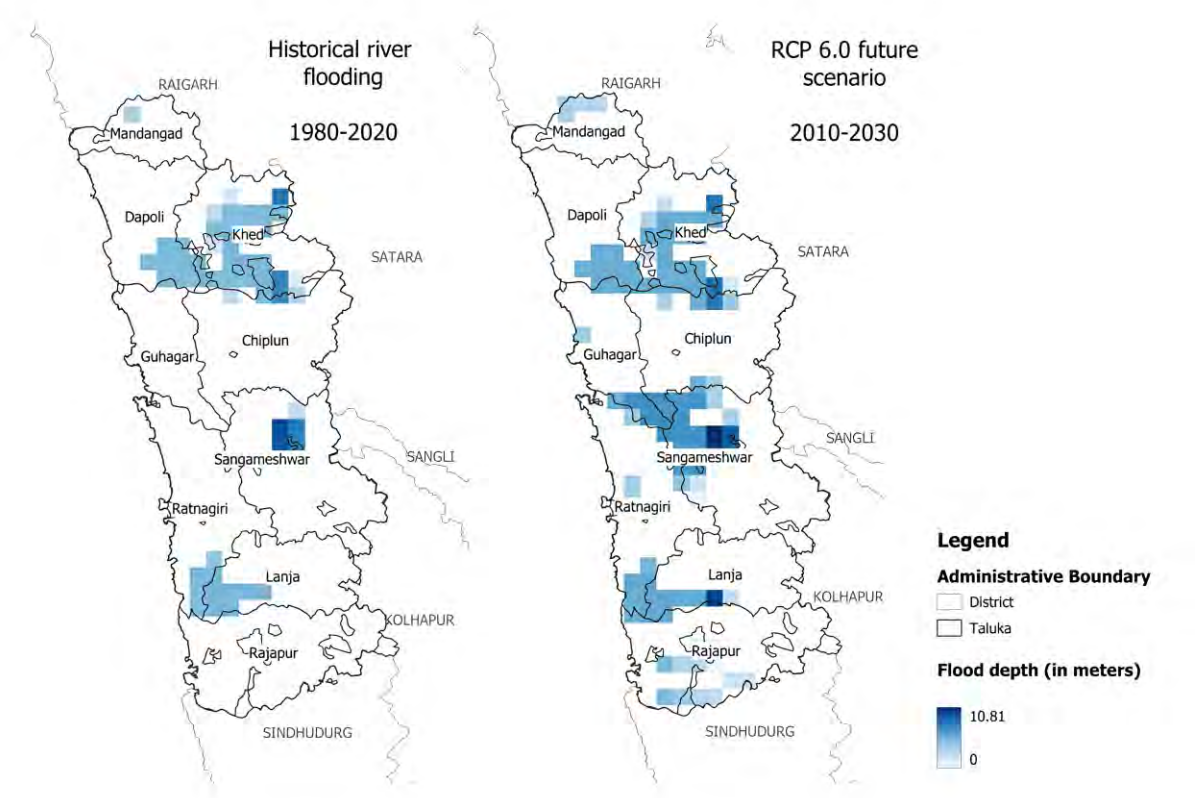
The talukas of Chiplun, Khed, and Sangameshwar are more prone to flooding, given their alignment along major river systems and their history of recurrent flooding. Parts of Lanja and Rajapur also show a progressive increase in flood extent. Overall, 548 villages (nearly one-third of all villages) fall within projected flood zones, underscoring the scale of socio-economic exposure. The future flood regime points to heightened risks to transportation corridors, agriculture, housing, and emergency services, while also signalling the need for updated zoning, watershed restoration, and strengthened early-warning and evacuation systems. The list of villages that are projected to experience flooding under the RCP 6.0 scenario has been provided in the Annexure 2.

Table 2: Flooded area (in km²) under historical and future scenarios

Flood Class (Depth in m)	Historical (1980–2000)	RCP 6.0 (2030–2050)
1–4 m	164.8 km²	535.6 km²
4–7 m	762.2 km²	1091.8 km²
7–11 m	144.2 km²	350.2 km²
Total Flooded Area	1071.2 km²	1977.6 km²

Source: iFOREST analysis based on CLIMADA model

Map 6: Spatial distribution of riverine flooding in Ratnagiri — Historical baseline (1980–2000) and projected inundation under RCP 6.0 (2030–2050)



Source: iFOREST analysis based on CLIMADA data

Table 3: Number of villages in flood zones under RCP 6.0 scenario

Taluka	No. of villages in flood zones (RCP 6.0 scenario)
Chiplun	53
Dapoli	36
Guhagar	31
Khed	114
Lanja	28
Mandangad	31
Rajapur	88
Ratnagiri	74
Sangameshwar	92

Source: iFOREST analysis

Landslides

Landslides are a major hazard in Ratnagiri due to its steep Western Ghats terrain, deep lateritic soils, high monsoon rainfall, and expanding road and settlement activity. The district has 262 identified landslide zones, affecting 167 villages, with risks concentrated along valley slopes and road corridors.

Sangameshwar, Ratnagiri, Chiplun, Guhagar, and Khed emerge as the most landslide-prone talukas. Sangameshwar alone accounts for 58 landslide points affecting 31 villages, driven by steep escarpments and intense rainfall. Coastal–interior transition zones in Rajapur and Mandangad also show notable clusters.

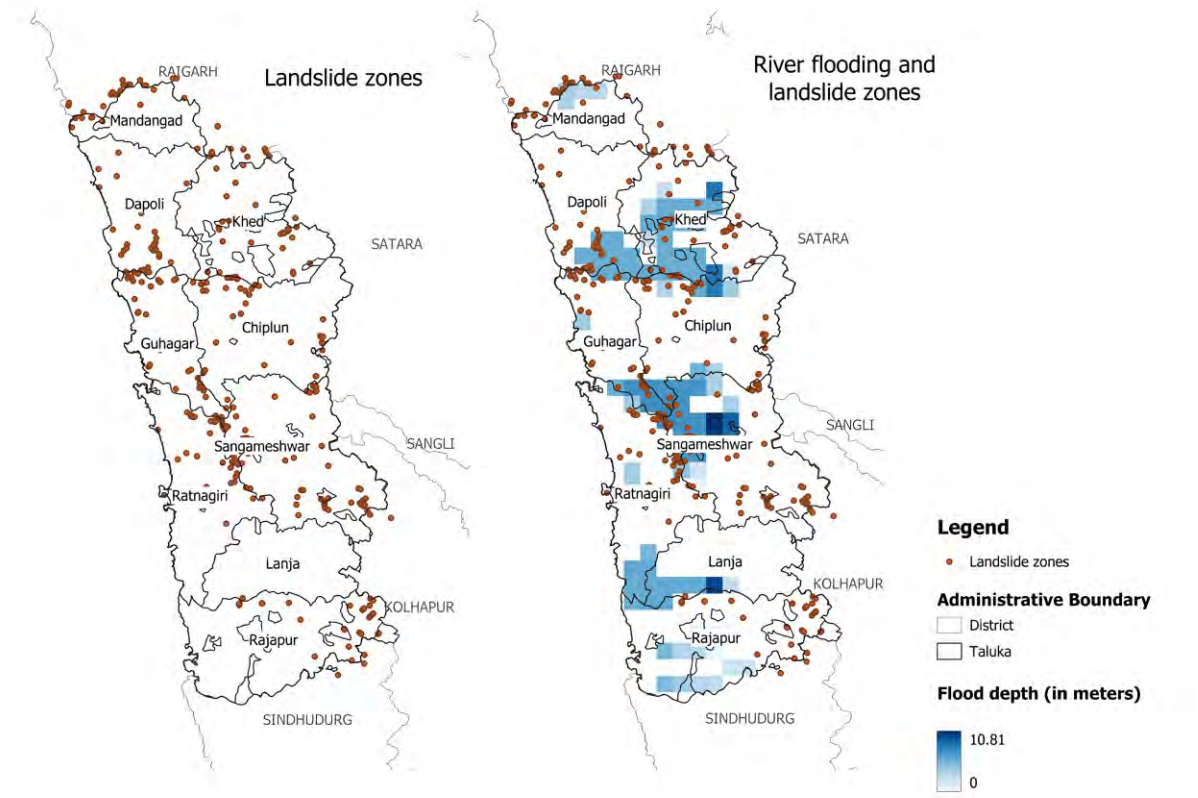
Table 4: Taluka-wise landslide zones

Taluka	Number of landslide zones	Number of villages in landslide zones
Sangameshwar	58	31
Ratnagiri	38	24
Rajapur	26	12
Mandangad	10	9
Lanja	1	1
Khed	29	22
Guhagar	33	21
Dapoli	29	22
Chiplun	38	24

Source: iFOREST analysis based on data from Geological Survey of India

The combined River Flooding & Landslides map highlights several overlapping hotspots—especially in Sangameshwar, Khed, and Chiplun—indicating cascading risks where saturated slopes, high river flows, and soil erosion interact during extreme rainfall. With projected increases in short-duration, high-intensity rainfall due to climate change, these landslide-prone areas are likely to face heightened instability, necessitating slope stabilizationsation, strict development controls, and early-warning systems. The list of villages that are prone to landslides has been provided in Annexure 3.

Map 7: Overlay of projected RCP 6.0 flooding zones and landslide occurrence points highlighting multi-hazard hotspots



Source: iFOREST analysis based on GSI and CLIMADA data

Cyclones & coastal storms

Ratnagiri is moderately exposed to cyclonic disturbances originating in the Arabian Sea, which have increased in frequency and intensity in recent decades. Although historically fewer cyclones made direct landfall along the Maharashtra coast compared to the eastern seaboard, the post-2000 period shows a marked rise in severe cyclonic storms (for example, Phyan 2009, Nisarga 2020, Tauktae 2021), influenced by warming sea surface temperatures and changing monsoon–cyclone interactions.

The district's hilly terrain, narrow river valleys, and deeply dissected lateritic plateaus amplify cyclone-related impacts. Strong winds, extreme rainfall, storm surges, and coastal flooding particularly affect exposed stretches such as Kelshi, Jaigad, Gavakhandi, Bhatye, Guhagar, Jaitapur, and Harnai, where shoreline recession and estuarine erosion have already been documented.[8]

Rising sea levels (3 mm/year) combined with silted estuaries and drowned coastal topography increase the likelihood of storm surge penetration into low-lying fishing villages, port settlements, and backwater ecosystems. Even cyclones that do not directly hit the district

generate high waves, tidal flooding, and damage to beaches, fish-landing centres, and coastal infrastructure.

While Ratnagiri does not face frequent high-intensity cyclone landfalls, its exposure to cyclone-associated hazards—storm surge, extreme rainfall, flash floods, and coastal erosion—is increasing, making coastal preparedness, early warning systems, and ecosystem-based buffers (mangroves, dunes) critical for long-term resilience.

B. Vulnerability profile

Coastal vulnerability (shoreline change & sea-level rise)

Ratnagiri's coastline faces multiple coastal hazards arising from sea-level rise, erosion, storm surges, and geomorphological sensitivity. The Coastal Vulnerability Index (CVI) categorises the district's shoreline into high-, medium-, and low-risk zones, identifying approximately 20 km as high risk.[9] Highly vulnerable stretches include Velas, Kelashi, Aade, Anjarle, Harnai, Guhagar, Palshet, Velneshwar, and Jaigad, where shoreline erosion and rapid coastal change are most pronounced. The CVI integrates parameters such as shoreline change rates, elevation, sea-level variation, coastal slope, tidal range, wave height, and geomorphology.

Shoreline change analysis indicates the following:

Table 5: Coastal vulnerability profile of Ratnagiri

Parameter	Category	Length (km)	Percentage	Rate / Height
Coastal Vulnerability	High-risk zone	20	7.2%	-
	Medium-risk zone	143	51.6%	-
	Low-risk zone	114	41.1%	-
Shoreline Change	High erosion	48 km	18%	5.3 m/year erosion
	Stable	150 km	54%	-
	Accretion	78 km	28%	2.4 m/year accretion
Tsunami Vulnerability	High risk	4 km	-	>3 m arrival height
	Moderate risk	9 km	-	2.3–3.0 m arrival height
	Low risk	264 km	-	0–2.3 m arrival height

Source: A B Yadav et al (2022)

Overall, these combined risks underscore the need for nature-based coastal protection, integrated shoreline management, and incorporation of CVI and tsunami-risk insights into district land-use planning and infrastructure development.

Socioeconomic vulnerability

Socioeconomic vulnerability across Ratnagiri was assessed using Principal Component Analysis (PCA), which helps reduce multiple correlated indicators into a smaller number of components to identify the factors that most strongly influence vulnerability. The analysis used indicators such as number of households, population below age 6, SC/ST population share, non-working population, agricultural labourers, total cultivators, marginal workers, female workforce participation, literacy levels, net sown and irrigated area, population density, distance to nearest town, housing condition and gender ratio.

Villages were grouped into five categories—Very high, High, Moderate, Low and very low vulnerability—based on their composite PCA scores. Ratnagiri district shows limited concentration of high-vulnerability pockets, with most villages falling in the Low or Very Low categories, indicating stronger socioeconomic resilience compared to several other districts in the region. The list of villages that are very high, high and moderately vulnerable has been provided in the Annexure 4.

However, specific pockets of high concern do exist. Only three talukas—Chiplun, Lanja, and Sangameshwar—contain a very high vulnerability village each. High vulnerability villages are found mainly in Dapoli, Ratnagiri, and Sangameshwar, while moderate vulnerability clusters appear across Chiplun, Dapoli, Guhagar, Ratnagiri and Sangameshwar. Khed, Ratnagiri, and Rajapur contain a larger share of very low vulnerability villages, pointing to stronger underlying socioeconomic indicators.

PCA further identified the top drivers of vulnerability:

- For the very high vulnerability group, the top drivers are:
  Marginal workers, number of households, young child population (0–6 years), female workforce participation, and total cultivators.

- For the high vulnerability group, the main drivers are:
  Number of households, SC/ST population share, young child population (0–6 years), female workforce participation and total cultivators.

- For the moderate vulnerability group, the top drivers are:
  Agricultural labourers, net area sown (in hectares), net irrigated area, total female workers and total cultivators.

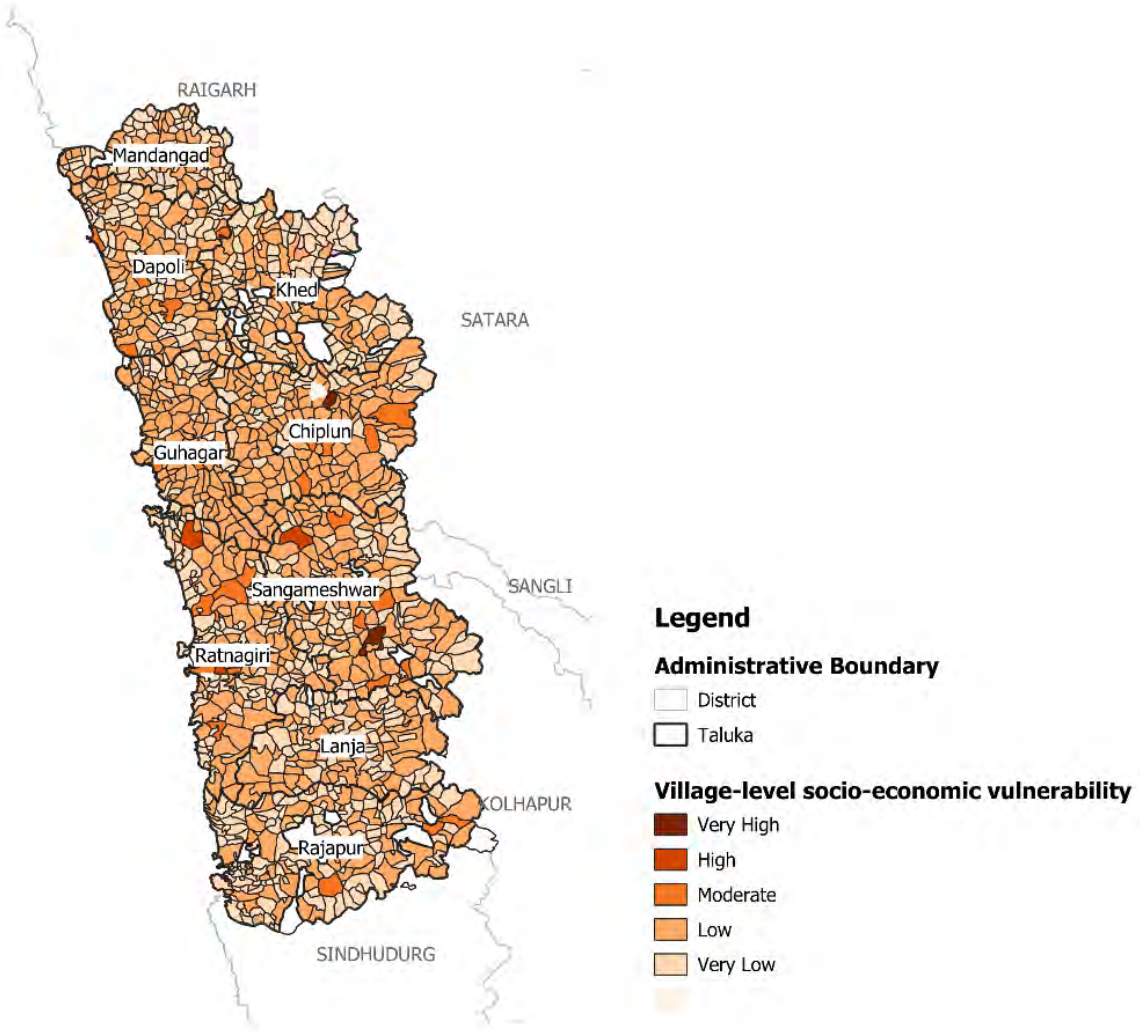
Table 6: Taluka-wise distribution of villages across socio-economic vulnerability classes

Taluka	Very high	High	Moderate	Low	Very low
Chiplun	1		5	108	51
Dapoli		1	5	76	94
Guhagar			2	86	34
Khed				61	118
Lanja	1			51	69
Mandangad				39	67
Rajapur			3	62	147
Ratnagiri		2	7	74	114
Sangameshwar	1	1	5	93	91

Source: iFOREST analysis

This distribution shows that while Ratnagiri's overall socioeconomic vulnerability is low, specific village clusters—particularly in interior and riverine talukas—require targeted strengthening of livelihoods, social protection, women's workforce participation, and early-childhood-focused interventions. These insights highlight the need to prioritise the small number of highly vulnerable clusters while enabling the district to leverage its overall strong socioeconomic base to accelerate resilience-building and low-carbon development.

Map 8: Village-level socio-economic vulnerability



Source: iFOREST analysis

1.2.3 Greenhouse gas (GHG) emissions profile

Ratnagiri district's annual greenhouse gas emissions are estimated at 7.8 million tonnes of CO_2 equivalent ($MtCO_2e$), dominated by the power sector, agriculture, and transport.[10] The emissions structure reflects the district's mixed coastal–agro–industrial economy and its dependence on grid electricity and fossil fuels.

Ratnagiri's per capita emissions (2024) stand at 4.4 tonnes per year, which is significantly higher than Maharashtra's average of 3.0 tonnes per year and the national average of 2.9 tonnes per year.

The power sector is the dominant emitter at 3.6 $MtCO_2e$, reflecting heavy dependence on grid electricity and fuel-based generation. The largest source within this sector is electricity generation. Agriculture is the second-largest contributor at 2.4 $MtCO_2e$, with emissions primarily from cropland fires, rice cultivation, and nitrogen fertiliser use. Cropland burning accounts for a sizeable share despite Ratnagiri's predominantly horticultural landscape, driven by residue burning in cashew, paddy, and mixed cropping systems.

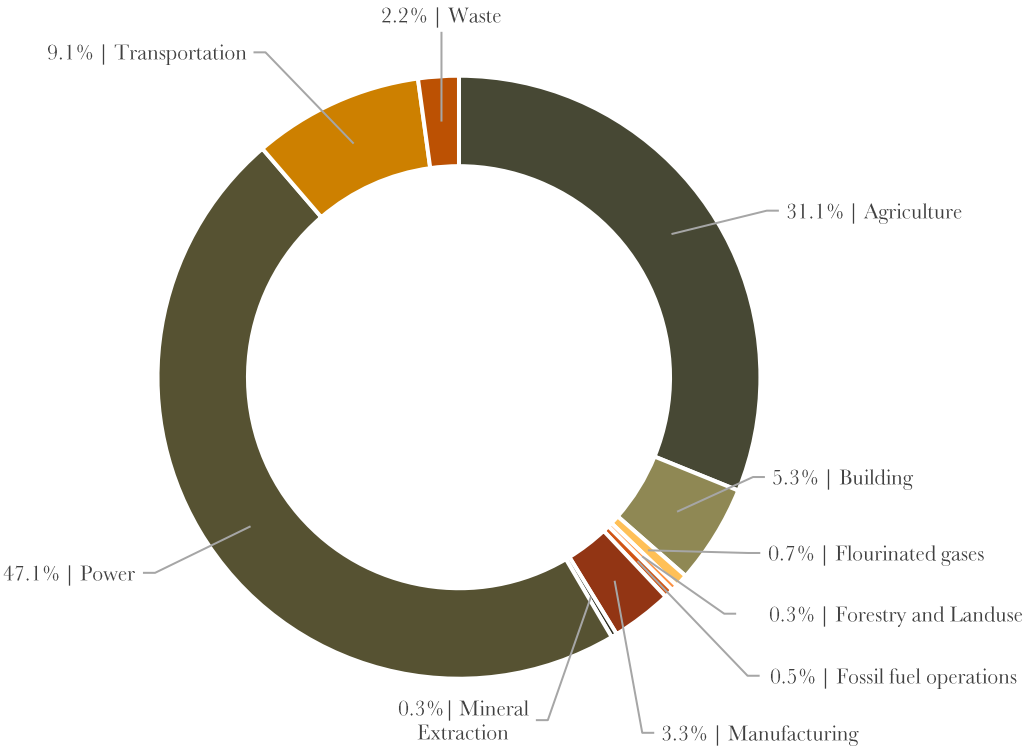
Transport emissions amount to 0.7 $MtCO_2e$, with international shipping—associated with Jaigad, Dabhol, and other minor ports—emerging as a significant source alongside road freight and passenger movement. Buildings generate 0.4 $MtCO_2e$, largely from residential on-site fuel use, including LPG, kerosene, and biomass for cooking and heating in both rural and peri-urban households.

Industrial emissions—which combine manufacturing (0.2 $MtCO_2e$) and fossil fuel operations (0.04 $MtCO_2e$)—are strongly influenced by iron mining and processing, small-scale food and agro-processing units, and diesel-based industrial machinery. Mineral extraction, though smaller at 0.02 $MtCO_2e$, is anchored by iron ore and lateritic stone mining, contributing fugitive dust and machinery-related emissions. Waste sector emissions (0.2 $MtCO_2e$) arise mainly from domestic wastewater treatment and discharge, reflecting limited sewage treatment infrastructure and reliance on septic tanks across urban and rural settlements.

Low but measurable emissions from forestry and land use (0.03 $MtCO_2e$) and fluorinated gases (0.05 $MtCO_2e$) are associated with forest land clearing for roads, housing, and plantations, and with refrigerant leakage from ACs and cooling systems.

Overall, Ratnagiri's emissions profile is shaped by a mix of grid-based energy demand, agriculture-linked methane and N_2O emissions, coastal transport activity, and household fuel use. This positions the district well for targeted mitigation efforts in energy transition, clean mobility, agriculture, waste management, and blue economy sectors.

Figure 7: Sector-wise Greenhouse Gas (GHG) emissions of Ratnagiri district, 2024



Source: Climate trace
*Data extracted in October 2025

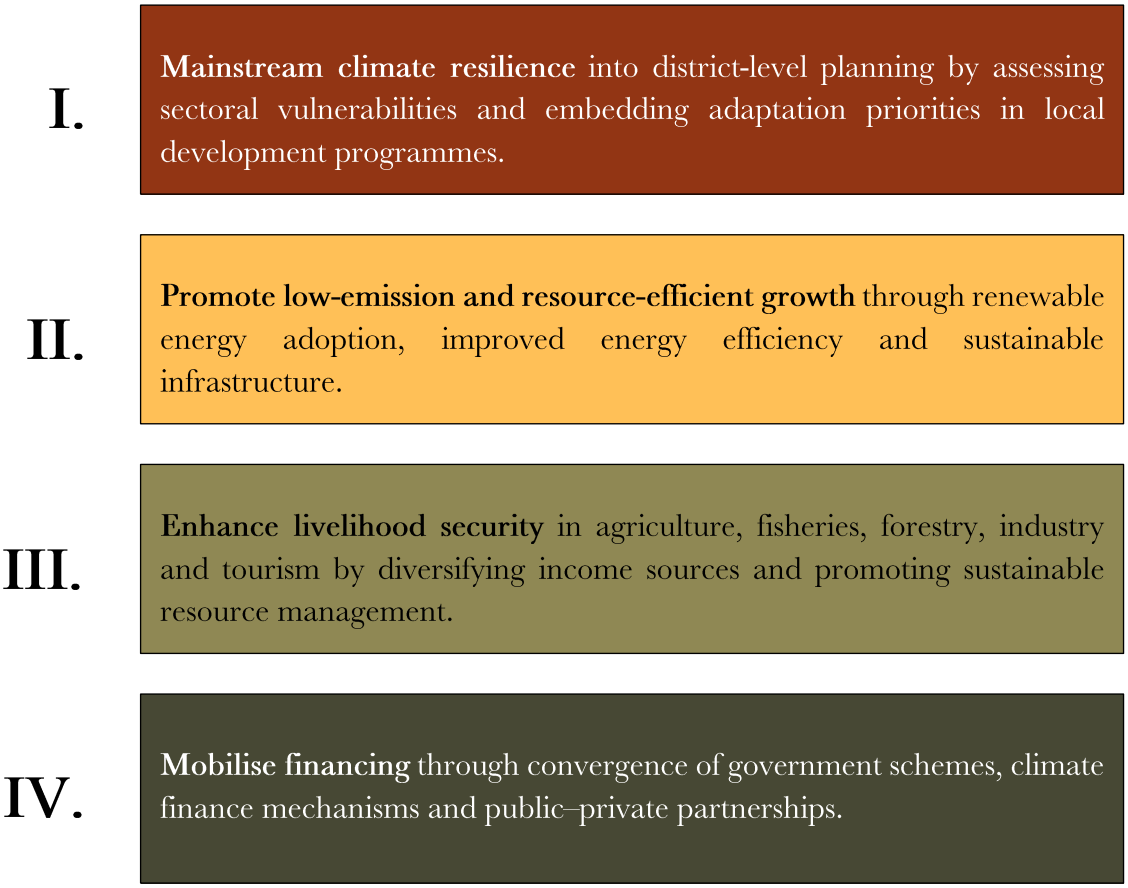
1.3 Vision and objectives

Ratnagiri's long-term development direction is outlined in the District Strategic Plan 2023–24, which positions the district as a model of inclusive, innovative, and sustainable growth. The strategy emphasises leveraging Ratnagiri's coastal and forest ecosystems as core development assets, aiming for balanced economic expansion rooted in agriculture, fisheries, tourism, and services, supported by catalytic industrial activity. The district has set an ambitious target of 14.9% annual growth, envisioning a USD 13-billion economy by 2028.[11]

Climate Change, however, poses significant risks to these development priorities—affecting agriculture and horticulture productivity, fisheries, infrastructure, water resources, and coastal settlements. Integrating climate resilience therefore becomes essential to sustaining long-term development.

Drawing from this context, the District Development-cum-Climate Action Plan adopts an integrated approach that aligns development goals with climate adaptation and low-carbon pathways.

Figure 8: Key objectives of the plan



These objectives align with Maharashtra's State Action Plan on Climate Change (SAPCC 2.0) and India's Nationally Determined Contributions (NDCs) under the Paris Agreement, ensuring that economic growth is pursued in a climate-resilient and environmentally sustainable manner.

The approach for the study is anchored in the central purpose of integrating climate considerations into district development planning.

The study follows a two-step methodology. First, it reassesses the existing District Strategic Plan to evaluate sectoral development strategies across important sectors—against identified climate risks, ensuring that ongoing development becomes climate-responsive. Second, it develops long-term climate pathways that look beyond the current plan period, outlining directions for low-carbon and resilient growth, disaster risk reduction, and enhanced carbon sinks. These pathways help guide future decisions on how land is used, how infrastructure is built and how the district can create new opportunities for green and sustainable growth.

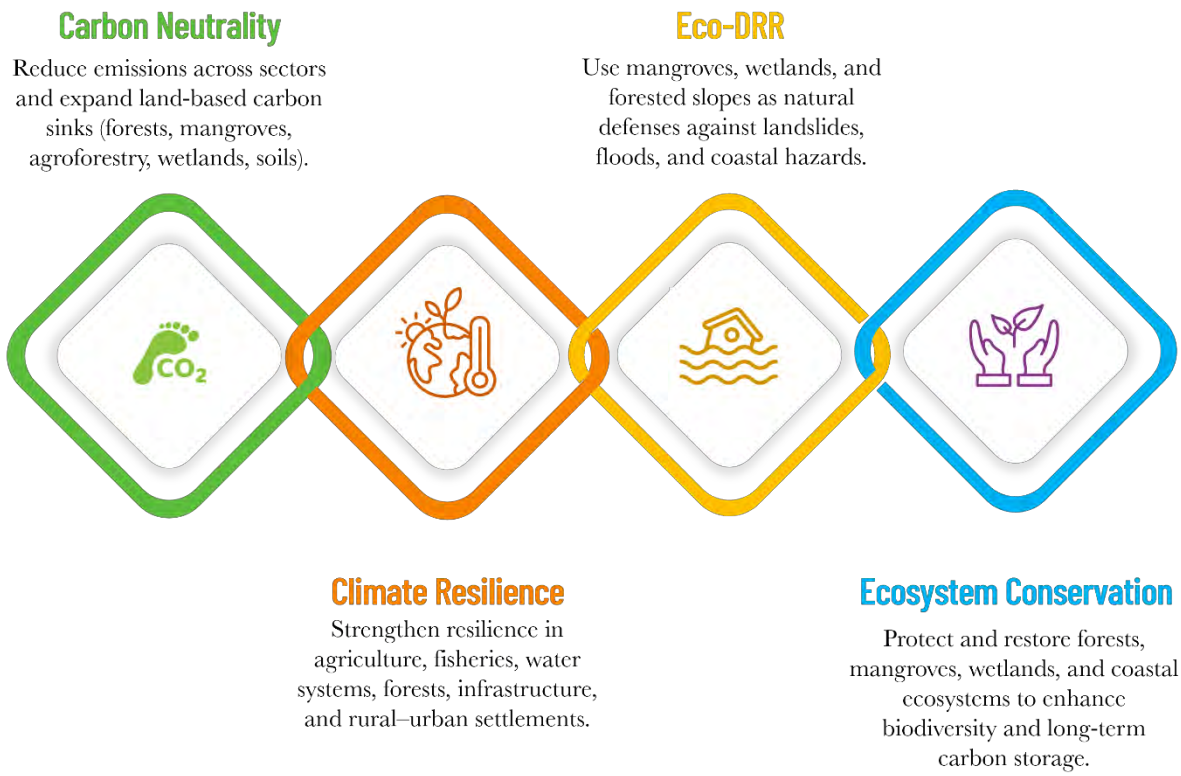
Chapter 2: Pathways to carbon neutrality and climate resilience

Ratnagiri's development trajectory will increasingly depend on its ability to respond to climate risks—rising temperatures, intense rainfall, recurrent floods and landslides, coastal hazards, and declining ecosystem stability. At the same time, the district possesses strong natural assets—Western Ghats forests, extensive mangrove systems, rich horticultural landscapes, and a long coastline—which position it the region uniquely to pursue low-carbon development and nature-based resilience.

Given its emission profile, climate risks, and ecosystem strengths, Ratnagiri can advance a combined agenda of low-carbon development, climate resilience, disaster risk reduction, and ecosystem conservation. These four pillars offer a clear and structured direction for the sectoral strategies that follow.

Ratnagiri can set the goal of becoming a carbon-neutral and climate-resilient district by 2050, driven by clean energy transition, ecosystem-based disaster risk reduction (Eco-DRR), and ecosystem conservation.

Figure 9: Four Strategic Goals for Ratnagiri 2050



This chapter outlines a long-term strategic pathway and act as a roadmap for Ratnagiri to transition toward a carbon-neutral and climate-resilient district by 2050. These sectoral pathways provide the overall direction of transformation. Specific five-year targets and operational strategies are presented subsequently in Chapter 3.

2.1 Carbon neutral and climate resilient strategies

2.1.1 Agriculture

Agriculture plays a central role in Ratnagiri's economy, livelihoods, and landscape management. The district's farming systems are shaped by its coastal–hilly geography, high rainfall, and rich horticulture base. Despite limited mechanisation, agriculture remains the backbone for rural households and has significant potential to support both climate resilience and carbon neutrality goals.

Agriculture in Ratnagiri is predominantly monsoon-dependent, with limited irrigation expansion due to undulating terrain and fragmented landholdings. Paddy is the principal crop, cultivated mainly in kharif, while millets and pulses are grown on a smaller scale. The district's unique agro-climatic conditions strongly favour horticulture—particularly mango, cashew, coconut, and arecanut—which form a major part of the local economy and hold substantial long-term carbon sequestration value.

The sector, however, contributes 2.4 Mt CO_2e (2024) of GHG emission, with the highest emissions coming from cropland fires and residue burning. As climate patterns shift, pressure on soil health, water availability and coastal lands has intensified, making the sector highly vulnerable while also positioned to deliver major climate benefits if steered strategically.

A. Key gaps and future opportunities

Although agriculture remains central to Ratnagiri's economy, several gaps continue to limit its climate resilience and low-carbon shift. At the same time, the sector holds significant potential for transformation through focused, district-level interventions.

Table 7: Key gaps and opportunities of agriculture sector

Key Gaps	Opportunities
1. High fertiliser dependence in paddy and some horticulture pockets leads to soil degradation and elevated nitrous oxide emissions. 2. Coastal erosion and salinity intrusion threaten long-term crop viability in low-lying belts.[15] 3. High reliance on single crops, especially rainfed paddy and monoculture orchards, limits resilience and heightens per-unit emissions. 4. Impact of increasing temperature on horticulture crops 5. Large volumes of horticulture residues—such as mango pruning waste, cashew shells and coconut husk—remain unutilised and are often burnt, adding to GHG emissions.	1. Significant potential to enhance Soil Organic Carbon through regenerative practices, cover cropping, and composting. 2. Crop diversification and introduction of climate-resilient horticulture crops 3. Existing mango and cashew orchards can function as major carbon sinks, with scope for multi-tier systems that add income and increase carbon sequestration. 4. Electrification of irrigation pumps, particularly through solar solutions, can substantially reduce emissions from diesel pumps. 5. Biochar production from abundant horticulture biomass, especially mango, cashew and coconut waste, can improve soil organic carbon in lateritic soils and reduce fertiliser use.

B. Carbon neutral strategies

The following carbon neutral strategies are proposed for the agriculture sector. Implementation will be led by the Agriculture Department, with support from relevant agencies.

Table 8: Carbon neutral strategies for agriculture sector

Sr. No.	Strategy priority	Key actions	Indicators	Relevant schemes/ agencies
1	Cropland fire management	- Establish a district wide, satellite and community-based monitoring system for real-time detection and reporting of crop fires. - Promote permanent transition to zero-burn agriculture, supported by incentives and biomass collection systems linked to biochar or composting units. - Introduce "No-Burn Panchayats" as a long-term behavioural and regulatory shift, integrated with biomass value chains.	- Number of reported fire events (declining trend) - Number of certified No-Burn Panchayats - Incentive disbursement records - Biomass collected and repurposed	Agriculture department Rain-fed area development (RAD) project National Mission on Sustainable Agriculture (NMSA) District Disaster Management Authority (DDMA)
2	Low-emission farming systems	- Expand micro-irrigation coverage - Adoption of solar-powered irrigation to reduce diesel and grid-based emissions. - Institutionalise soil health management, including routine soil testing - Long-term shift towards biofertilisers and balanced nutrient practices. - Promote low-methane paddy systems (SRI, AWD, direct-seeded rice) through	- Area under micro-irrigation - Number of solar pumps installed - Soil health card coverage - Biofertiliser uptake - Area under SRI / low-methane paddy	Agriculture Department & ATMA (Agricultural Technology Management Agency) Paramparagat Krishi Vikas Yojana (PKVY)

		continuous farmer capacity-building.		National Mission on Natural Farming (NMNF) Magel Tyala Saur Krushi Pump Yojana (Solar Pump Scheme) PMKSY – Per Drop More Crop
3	Climate-Smart Livestock Management	- Develop dairy cluster–based biogas systems to replace firewood with biogas for cooking. - Expand farmer training on improved manure management (aerobic composting, slurry utilisation, methane reduction practices) as a continuous program. - Promote clean livestock housing, improved fodder systems, and manure-to-energy models.	- Biogas units installed - Households shifting from firewood to biogas - Farmers trained on improved manure management - Manure management adoption rates	Animal Husbandry Department National Livestock Mission (NLM)
4	Carbon-rich horticulture & agroforestry	- Develop dedicated agroforestry clusters to promote multi-tier horticultural and coastal agroforestry models. - Promote windbreak plantations in coastal areas to strengthen climate resilience. - Establish long-term carbon-credit programmes through FPOs for horticulture and agroforestry landscapes, ensuring clear and fair	- Area under agroforestry - Farmers linked to support services - Volume of carbon credits generated - Number of farmers enrolled in carbon programmes	Mission for Integrated Development of Horticulture (MIDH) Bhausaheb Fundkar Falbag Lagvad Yojana, Public–Private Partnership (PPP)

		farmer revenue-sharing mechanisms.		
5	Biochar management	- Establish pyrolysis units for long-term biomass-to-biochar conversion, especially for mango, cashew, and coconut residues. - Strengthen biochar supply chains by organising producer groups for biomass aggregation. - Promote biochar application in croplands to increase soil organic carbon and reduce fertiliser requirements.	- Number of pyrolysis units - Volume of agro-residues converted - Area under biochar application - SOC increase - Reduction in fertiliser use	-Department of Agriculture -NMSA - Private sector and FPOs

C. Climate Resilient Strategies

The following climate resilient strategies are proposed for the agriculture sector.

Table 9: Climate resilient strategies for agriculture sector

Sr No.	Strategy priority	Key actions	Indicators	Relevant schemes
1.	Water management; flood and erosion control	- Promote moisture-retaining intercrops (pulses, green manure) on rainfed farmland to reduce soil moisture loss and enhance soil health. - Construct recharge pits and farm ponds in suitable upland and mid-slope areas to reduce runoff and enhance infiltration and water	- Area (ha) under moisture-retaining intercrops - Number of farmers adopting intercrops - Number of ponds and recharge pits constructed - Total length (km) of vegetative bunds	Agriculture Department, PMKSY, Jal Kund Scheme, Farm Pond Scheme

		availability. - Establish vegetative bunds using bamboo and vetiver on erosion-prone slopes to stabilise bunds and reduce soil loss.	created	
2.	Climate-sensitive and diversified crop systems	-Diversify monoculture rice areas into millets, pulses, and vegetables to reduce water demand and strengthen climate resilience. -Promote short-duration and saline-tolerant paddy in coastal belts. -Expand Integrated Farming Systems (IFS) to enhance diversification, nutrient recycling, and risk reduction.	- Area (ha) converted to diversified crops - Area (ha) under saline-tolerant or short-duration paddy - Number of households adopting Integrated Farming Systems - Number of farmers shifting from rice monoculture	Agriculture Department, PMKSY – Per Drop More Crop; NMSA
3	Climate sensitive Horticulture	- Promote heat- and drought-tolerant horticulture varieties - Expand protected cultivation (shade nets, polyhouses) for climate-vulnerable horticulture clusters. - Strengthen early warning & pest surveillance for climate-sensitive horticulture zones. - Encourage high-value under-canopy crops (cocoa, coffee, vanilla) in multi-tier orchard systems	- % of horticulture area under climate-resilient varieties - Area (ha) brought under protected cultivation annually - Number of horticulture clusters covered by pest and disease surveillance -Area under multi-tier orchard systems	Agriculture Department, Krishi Samruddhi Yojana MIDH National Horticulture Board (NHB)
4.	Integrated pest and	- Introduce pheromone traps, biological control	- Number of farmers trained or	Agriculture Department,

	disease management (IPDM)	agents, and neem-based biopesticides through demonstration -Conduct farmer trainings to reduce chemical pesticide dependence.	adopting pheromone traps/biopesticides - Reduction in chemical pesticide consumption (%)	National Food Security Mission (NFSM) CROPSAP (Crop Pest Surveillance and Advisory Project) HORTSAP (Horticultural Crop Pest Surveillance and Advisory Project)
5.	Establish agriculture and food processing units and promote low-carbon processing technologies	-Promote local cold storage and small RE-powered cold rooms to reduce post-harvest losses under rising heat and humidity. -Support entrepreneurship and FPO-led processing units (mango, cashew, spices, fish) to strengthen climate-resilient value chains. - Promote low-carbon processing technologies, such as solar dryers and energy-efficient equipment.	- Number of solar dryers - Number of food-processing units using low-carbon technologies	Agriculture Department, The Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME) NABARD Ministry of Food Processing Industries (MoFPI)
6.	Strengthen agro-advisory and early warning systems	- Provide timely block-level weather advisories and early warnings. - Disseminate advisories through SMS/WhatsApp, community information boards, and digital advisory platforms.	- Number/ percentage of farmers receiving advisories - Frequency and timeliness of advisories	Agromet Advisory Services (AAS) by India Meteorological Department; AAS by Dr. Balasaheb Sawant Konkan

				Krishi Vidyapeeth Krishi Vigyan Kendras (KVKs)

2.1.2 Energy

The energy sector is a major pillar of Ratnagiri's economy, shaped largely by two large power plants that together generate more than 3,100 MW of electricity. The gas-based plant at Dabhol, operated by RGPPL, contributes 1,967 MW, while the 1,200 MW JSW Energy plant at Jaigad provides steady coal-based power to the state grid.[16]

Electricity consumption in the district reached 1,013 million units in 2023–24, with industries using almost half and the household–commercial segment accounting for most of the rest.[17] This strong dependence on fossil-fuel-based generation results in sectoral emissions of about 3.68 Mt CO_2e each year.

While renewable energy remains limited at present, important steps toward clean and flexible power systems are now underway. One such development is the Maharashtra Government's agreement with Waterfront Construction Pvt. Ltd. to set up a 1,750 MW pumped storage hydropower project in Lanja, bringing significant investment and new employment opportunities to the district.[18]

Overall, Ratnagiri has an established conventional power base, high emissions from large thermal plants, and new openings for low-carbon energy infrastructure that can support a more balanced energy mix in the future.

Box 1: Electricity Generation Capacity Required by 2050

Annual electricity consumption in Ratnagiri for 2023–24 was 1,013 million units (MU) (i.e. 1,013 GWh). With an estimated current population of 1.7 million, this equates to roughly 595 kWh per capita per year—well below India's national average of 1,395 kWh in 2023–24.[1] Ratnagiri's lower per capita consumption reflects its predominantly rural/semi-urban character and limited industrial load.

For Ratnagiri to become a $7,500-10,000 per capita economy by 2050, the per capita electricity consumption will need to increase by 6-8 folds.

By 2050, assuming a population of 2 million and per capita electricity consumption of 4,000 kWh/year, total annual demand is expected to rise to 8,000 MU (8,000 GWh/year). This is about eight times the 2023–24 consumption, reflecting higher usage per person even as population grows moderately.

This requirement can be met from 4,000 MW solar/wind capacity and 14,000 MWh of storage. These can be easily developed in Ratnagiri considering its high renewable and storage potential.

Source: iFOREST analysis

A. Key gaps and future opportunities

The sector has gaps linked to high dependence on fossil-fuel generation, yet there is strong potential to shift toward cleaner power sources.

Table 10: Key gaps and opportunities of energy sector

Key Gaps	Opportunities
1. Limited renewable energy penetration 2. Declining operation of RGPPL due to recurring gas shortages and operational interruptions. 3. Limited installation of solar rooftops and solar pumps. 4. Burning of surplus biomass	1. Very high renewable energy potential in the district[19] i. Ground Mounted Solar Potential over Wasteland - 13,000 MW ii. Floating Solar Photo Voltaic Potential - 700 MW iii. Wind Energy Potential Over Wasteland - 4,500 MW iv. Roof top Solar Potential - 400 MW v. Total Potential - 19,000 MW 2. Very high surplus biomass for energy generation

Box 2: Ratnagiri district Renewable energy potential

Ratnagiri district has a significant opportunity for large-scale RE development, particularly ground-mounted solar and wind, given its mix of wasteland availability, coastal conditions, and high solar insolation. As per iFOREST's analysis, the district's RE potential is estimated to be around 19,000 MW. This includes ground-mounted solar, floating solar, wind energy, and rooftop solar options, positioning Ratnagiri as an important contributor to Maharashtra's clean energy transition.

Among the different RE sources, ground-mounted solar offers the highest potential, estimated at 13,000 MW across wasteland areas of the district. This forms the largest share of Ratnagiri's overall RE capacity.

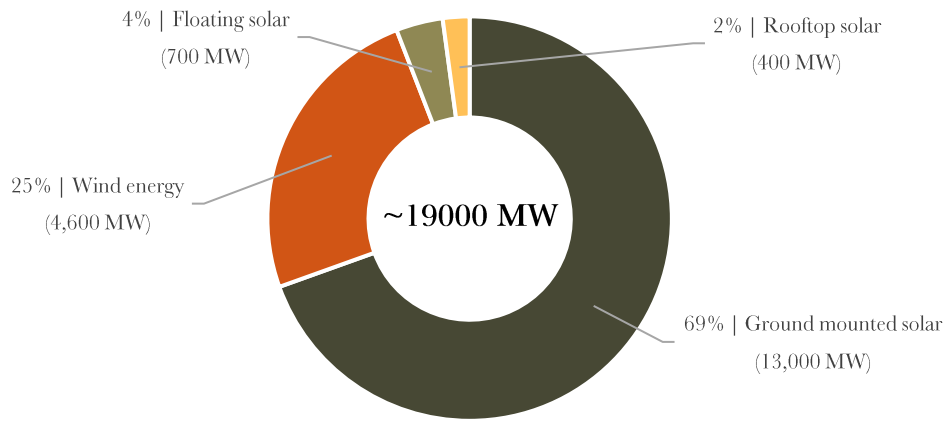
The district also holds considerable potential for floating solar, leveraging 72 reservoirs and other inland water bodies. The total floating solar capacity is estimated at 700 MW.

Alongside solar, the district has notable wind energy potential, estimated at 4,500 MW over suitable wasteland. This provides a strong foundation for diversified and hybrid RE development, especially given the region's coastal wind conditions.

Urban and semi-urban areas add further capacity through rooftop solar, with an estimated potential of 400 MW. This distributed generation opportunity can support households, commercial establishments, and public buildings in reducing grid dependence.

Harnessing this sizeable resource base can accelerate Ratnagiri's shift towards a cleaner energy mix, promote green industries, and unlock new opportunities for local employment, investment, and sustainable development.

Figure 10: RE potential in the district



Source: iFOREST analysis

Box 3: Surplus biomass energy in Ratnagiri

iFOREST analysis shows the estimated biomass energy surplus for Ratnagiri district across cropping seasons and major crop categories, amounting to a total surplus of 1,507,458 GJ. This is equivalent to about 75,000 tonnes of coal. This indicates strong potential for biomass-based energy applications in the district.

Table 11: Estimation of surplus biomass energy by crop and season in the district

Season	Crop	Area (Hectare)	Yield (Tonne/Hectare)	Surplus Biomass Energy (GJ)
Rabi	Maize	34	3	863
	Other rabi pulses	7,282	0.7	32,298
	Other cereals	17	1	113
	other oilseeds	65	0.6	338
Kharif	Arhar/Tur	43	0.6	226
	Groundnut	11	0.9	53
	Other cereals	382	0.8	2,051
	Other kharif pulses	39	0.6	127
	other oilseeds	0.3	0.3	0.7
	Ragi	10,050	1	73,731
	Rice	69,190	3	13,93,470
	Sesamum	17	0.3	48
Summer	Groundnut	32	2	396
	Moong (Green Gram)	4	0.2	6
	other oilseeds	0.7	0.6	3
	Other summer pulses	63	0.5	146
	Rice	10	4	253
	Urad	1	0.5	4
Whole year	Sugarcane	19	80	3331
Total		87,260	100	15,07,500

Source: iFOREST analysis

B. Low carbon and climate resilient strategies

The following carbon neutral strategies are proposed for the energy sector. Implementation will be led by the Energy Department, with support from relevant agencies.

Table 12: Low carbon and climate resilient strategies for energy sector

Sr No.	Strategy priority	Key actions	Indicators	Relevant schemes/agencies
1.	Decommissioning and repurposing of the RGPPL power plant	- Undertake phased techno-economic assessment for repurposing the plant into renewable/industrial use (solar park, green hydrogen, industrial zone). - Develop long-term worker transition and reskilling programmes for affected employees.	- Repurposing option finalised - Number of workers transitioned	Mahagenco PPP
2	District-scale Renewable energy expansion (Solar, Wind, Agri-PV & Biomass)	- Prepare district renewable energy potential map - Promote large-scale deployment of solar and wind (ground-mounted, rooftop, floating). - Enable agri-PV systems for dual land use (crops + solar generation). - Promote solarisation of agricultural feeders and individual farm-level pumps to reduce irrigation emissions. - Support deployment of biomass gasifiers and small biomass power plants using cashew shell, coconut waste, and	- MW of new RE capacity added - Share of RE in district energy supply - Area (ha) under agri-PV	PM-KUSUM Rooftop Solar Programme PM Surya Ghar: Muft Bijli Yojana Maharashtra Energy Department PPP

		agro-residues as part of the district's RE mix. - Encourage private sector participation in RE parks and distributed RE through streamlined approvals and land pooling.		
3	Decentralised Solarisation of public & community infrastructure	- Solarise schools, PHCs, hospitals, anganwadis, government offices, and community buildings through rooftop or decentralised clean-energy systems. - Provide reliable hybrid RE solutions for critical services such as rural clinics and cold rooms - Convert streetlighting in urban local bodies to LED and solar-based systems. - Promote rooftop solar adoption in residential areas through subsidy and community programmes.	- No. of public buildings/facilities solarised - %streetlights on LED/solar -Increase in rooftop solar installations	PM Surya Ghar: Muft Bijli Yojana MNRE programmes
4	Electric Mobility and charging infrastructure	- Develop district-wide EV charging infrastructure, including fast-chargers at key mobility nodes. - Encourage EV adoption in public transport and municipal fleets. - Facilitate private-sector	- Number of charging stations installed - Increase in EV adoption across segments	PM E-Drive scheme

		EV charging stations in tourism circuits, ports, industrial areas, and logistics hubs.		
5	Clean Energy access for coastal and remote hamlets	- Provide decentralised clean-energy solutions such as solar home systems, micro-grids, and hybrid RE systems. - Prioritise remote fishing, tribal, and forest hamlets to ensure reliable energy access in off-grid or underserved areas.	- Number of decentralised RE systems deployed - Reduction in diesel genset usage in remote areas	Deendayal Upadhyaya Gram Jyoti Yojana (DDUGJY)

2.1.3 Fisheries

Ratnagiri has a long-standing and deeply rooted fisheries economy shaped by its 167 km coastline and 99 fishing villages, many of which have depended on the sea for generations. There are 46 fish landing centers and one minor fishing harbour is present in this district. Nearly 70,000 people belong to the fishing community, with around 14,000 full-time/active marine fishermen operating from 118 coastal settlements, making the sector an important livelihood source.[20] Even though its formal contribution to the GDDP remains modest at about 1%.[21] The total number of fishing boats operating in Ratnagiri is 3038 out of which 2267 are mechanised and 771 are non-mechanised.

Marine fisheries continue to dominate because of the district's wide continental shelf and productive nearshore waters. At the same time, inland fisheries are traditionally limited by the hilly terrain and short river systems, are gradually expanding. In recent years, areas with suitable ponds, estuarine stretches, and brackish-water zones have seen growth in small-scale aquaculture. This shift is reflected in the district recording 1,560 metric tonnes of inland fish production in 2022–23, signalling steady progress toward aquaculture diversification.[22]

A. Key gaps and future opportunities

The fisheries sector remains socially significant, economically modest, and environmentally sensitive which makes climate resilience and sustainable resource management essential for its long-term stability. The sector faces several climate-related challenges that also open clear opportunities for strengthening resilience and sustainability.

Table 13: Key gaps and opportunities of fisheries sector

Key Gaps	Opportunities
1. Limited infrastructure for cold storage, processing, and fish handling 2. High vulnerability of fishers to cyclones, unpredictable weather, and seasonal declines in catch 3. Limited alternative livelihood options within the fisheries economy	Significant scope to increase value addition in fisheries through climate-resilient fisheries and diversified aquaculture.

B. Low carbon and climate resilient strategies

Fisheries strategies draw upon climate diagnostics from Chapter 1, particularly rising sea surface temperatures, increasing cyclone-associated hazards, and high-vulnerability shoreline stretches that shape the future stability of marine livelihoods. The following low carbon and climate resilient strategies are proposed for fisheries sector. Implementation will be led by the Fisheries Department, with support from relevant agencies.

Table 14: Low carbon and climate resilient strategies for fisheries sector

Sr No.	Strategy priority	Key actions	Indicators	Relevant schemes/agencies
1.	Building climate-resilient fisheries and safety systems	- Expand real-time Ocean State Forecast (OSF) and multi-hazard early warning coverage to all fishing villages. - Provide reliable communication devices (VHF, GPS, digital radio) for safe marine navigation. - Upgrade landing centres and harbours with storm-resilient berthing, strengthened jetties, and climate-proof ice storage and handling facilities.	- % fishing villages with OSF/early warning coverage - No. of fishers using communication devices - No. of landing centres upgraded	Fisheries Department Pradhan Mantri Matsya Sampada Yojana (PMMSY)
2.	Fuel & energy transition in marine fishing	- Promote adoption of fuel-efficient, hybrid diesel–solar–electric engines in mechanised and motorised fishing fleets.	- Number of hybrid/low-emission engines in use	Fisheries Department PMMSY – Mechanisation &

		- Support gradual transition to low-emission fishing operations through incentives, retrofits, and modernisation support. - Encourage research and pilots on electric or hydrogen-ready fishing vessels in collaboration with technical institutes.	- % reduction in diesel consumption - Number of boats adopting transition pathways	Modernisation Component PPP
3	Renewable energy for Onshore operations	- Promote installation of renewable-energy-powered ice plants and cold rooms across major harbours and fish-landing centres. - Deploy solar dryers and renewable-powered processing systems for fish drying, curing, and value-addition in coastal villages. - Encourage adoption of solar-powered refrigeration for transport and storage to reduce spoilage and energy costs.	- Number of solar-powered ice plants/cold rooms - Number of fishing villages using solar dryers - Reduction in fossil-fuel use in onshore operations	Fisheries Department Non-Conventional Energy Development Scheme PPP
4	Circular fisheries economy: waste management, biochar & biogas integration	- Integrate fisheries waste (fish offal, shell waste, and market waste) into district-level biomass or biochar processing systems. - Establish decentralised fish-waste collection and segregation at landing centres to enable circular waste-to-energy and fertiliser pathways. - Promote partnerships with agriculture/horticulture sectors to use processed biochar or digestate for soil improvement.	- Tonnes of fish waste processed annually - % of landing centres practicing segregation - Reduction in open-dumping hotspots along the coast	Fisheries Department PMMSY – Post-Harvest Management Component PPP

2.1.4 Building and infrastructure

The building and infrastructure sector in Ratnagiri district is at a pivotal stage of development. Between 2017 and 2024, the built-up area increased from 195 sq. km to 406 sq. km, representing a 108% growth and reflecting rapid urbanisation.[23] In 2022-23, the construction sector contributed 6% to the district GDDP, while transport contributed 4%, collectively accounting for 10% of the district's economic output.[24]

This rapid expansion has come with a significant environmental footprint. In 2024, the sector was responsible for 1.18 Mt CO2e, or 15.16% of the district's total greenhouse gas emissions.[25] In addition, urban growth has increased demand for residential, commercial, and industrial infrastructure: the district currently hosts over 250 km of major roads, more than 1,500 registered construction enterprises, and a growing number of logistics and industrial facilities.[26]

Future development pressures are expected to rise. The Nagpur-Goa Expressway corridor is projected to increase tourist arrivals over the next five years, creating demand for resorts, hotels, and ancillary infrastructure. Similarly, the growth of godowns, warehouses, and industrial areas to support trade and logistics will drive further construction activity. Together, these trends indicate that, without intervention, the sector will lock in high-carbon infrastructure, increase resource consumption, and exacerbate waste management challenges.

A. Key gaps and future opportunities

While the sector continues to expand, several structural gaps constrain its climate resilience and low-carbon transition. At the same time, there remains considerable potential for improvement through targeted, district-led interventions.

Table 15: Key gaps and opportunities of building and infrastructure sector

Key Gaps	Opportunities
1. Absence of certified green buildings – The district is yet to develop any officially recognised green building project. 2. Low prioritisation of energy efficiency – Rapid expansion of the building sector has not been accompanied by adoption of energy-efficient standards or technologies. 3. Inadequate quality tourism infrastructure – Rising tourism demand is not matched by sufficient high-quality green resorts and hotels. 4. Construction and Demolition (C&D) waste management deficiency – No dedicated C&D processing facility; debris is dumped informally or mixed with municipal waste.	1. Promotion of district-wide green building development 2. Leveraging policy and incentives to mainstream energy-efficient and sustainable construction practices. 3. Green and Eco-tourism development. 4. Tapping into the rising tourism demand while ensuring minimal environmental footprint through sustainable infrastructure. 5. Capacity building for low-carbon construction materials 6. Encouraging the use of fly ash, slag, bamboo, and other alternative materials that reduce embodied carbon.

Box 4: Pimpri-Chinchwad's green building push – a model for Ratnagiri

Pimpri-Chinchwad has emerged as a national leader in municipal-led green building reforms. The city adopted a clear mix of incentives, regulatory requirements and institutional partnerships that nudged the construction sector toward sustainable practices.

Key interventions:

i. **Property tax rebates -** 5% for IGBC/GRIHA-certified homes and 10% for certified commercial buildings
ii. **Fast-track approvals** for green-compliant projects
iii. **Mandatory DCR provisions that includes -** Solar water heaters, Rainwater harvesting, Energy-efficient common-area lighting, Waste segregation & on-site composting
iv. **Capacity-building:** Training for architects, engineers and builders
v. **Partnership:** IGBC support for evaluation and certification

The results were significant: more than 350 buildings registered under green rating systems, with certified buildings cutting operational energy use by 18–25% and accelerating rooftop solar uptake.

Source:

1. PCMC. "Green Building – SVAGRIHA." Pimpri-Chinchwad Municipal Corporation, pcmcindia.gov.in, https://www.pcmcindia.gov.in/green_building_svagriha.php

2. GRIHA Council. "Operationalisation of GRIHA." GRIHA India, grihaindia.org, https://www.grihaindia.org/operationalisation-griha

3. Indian Express. "Pune: 10,583 flat owners get tax rebate for green projects in Pimpri-Chinchwad." The Indian Express, 6 Nov. 2022, https://indianexpress.com/article/cities/pune/10583-flat-owners-get-tax-rebate-for-green-projects-8252108/

B. Low carbon and climate resilient strategies

Priorities in this sector respond to the land-use shifts, expanding built-up areas, and multi-hazard risks—especially landslides, flooding, and coastal exposure. Climate-resilient planning is therefore fundamental to future-safe infrastructure development.

The following carbon neutral and climate resilient strategies are proposed for the Building and Infrastructure sector. Implementation will be led by the Urban Development Department, with support from relevant agencies.

Table 16: Low carbon and climate resilient strategies for building and infrastructure sector

Sr No.	Strategy priority	Key actions	Indicators	Relevant schemes/agencies
1	Green Buildings			
1.1	Minimum Green Standards for all new Commercial, Hotel and Government Buildings	- Ensure all new government buildings meet Energy Conservation and Sustainable Building Code (ECSBC) 2024-compliant energy-efficient design standards. - Integrate ECSBC norms directly into PWD tender conditions and district-level technical approvals.	- % of new govt buildings meeting ECSBC standards - % of new commercial buildings and hotels	ECSBC Code Municipal Corporation Urban Development Department (UDD)
1.2	Integrate Green-Building Clauses into ULB Building Permissions (via district directive)	Issue a district circular directing all Municipal Councils / Nagar Panchayats to adopt ECSBC compliance for eligible buildings (commercial, hotels, hospitals, and educational institutions) Implement Eco-Niwas Samhita (ENS) 2024 for residential building Promote wastewater recycling on-site for hotels, lodges, resorts, hospitals. Include green criteria in all government schemes supporting homestays, agro-tourism, warehouses and industrial sheds (MIDC to follow District advisory)	% new buildings with ECSBC and ENS permission No. of ECSBC/ ENS-compliant buildings	District administration Municipal Councils / Nagar Panchayats (Urban Local Bodies) Maharashtra Tourism Development Corporation (MTDC)
1.3	District-level cool roof & energy efficiency	- Adopt and implement Cool Roof Guidelines for all govt buildings, schools, anganwadis, and health facilities.	No. of cool roofs installed	UDD PPP models PWD

		- Develop village-level demonstration buildings showcasing low-carbon construction and passive cooling design.		
2	Construction materials, C&D circularity & low-carbon practices			
2.1	Strengthen district C&D waste collection & processing system	- Establish a district-level C&D waste processing facility and enforce ULB-level collection systems through district directive. - Enable PPP participation for long-term processing, recycling, and material recovery.	Tonnes C&D processed annually	Swatchh Bharat Mission PWD Zilla Parishad
2.2	Mandatory use of recycled C&D materials in government projects	- Mandate 10–20% recycled aggregate use in PWD, rural roads, irrigation, PHED, and ULB infrastructure projects. - Strengthen PWD and ULB enforcement protocols for green procurement	- % govt projects using recycled aggregates	
2.3	Cluster-level material recovery yards for rural blocks	- Set up block-level recovery/storage yards (one per 2–3 blocks) to store stone, bricks, metal, timber and reusable demolition components. - Integrate material recovery into local construction supply chains.	- No. of functional yards	
2.4	Training & accreditation for local contractors and engineers	- Implement joint training programmes with PWD, ULBs and ITI to certify contractors/masons in C&D waste management, low-carbon materials, and green construction methods.	No. of personnel certified No. of training sessions held	

2.1.5 Industry

The industrial sector in Ratnagiri is a significant component of the district economy, contributing 23% to the GDDP in 2022–23.[27] This share has remained broadly constant in recent years. The district hosts 2,379 registered industrial units (2023–24) distributed across pollution categories as reported in the District Socio-Economic Review: 392 Red, 927 Orange, 952 Green and 108 White units.

In 2024 the industrial sector's greenhouse-gas emissions were estimated at 0.25 million tonnes CO_2e.[28] Industrial activity spans food and marine product processing, agro-based units, small-scale manufacturing and chemical/processing units located primarily in established industrial pockets and MIDC estates across the district.

Ratnagiri's industrial infrastructure includes a mix of organised estates, smaller industrial pockets and port-linked facilities that support processing and logistics. With this established base of registered units and steady economic contribution, the sector remains an important component of the district's production and trade landscape.

A. Key gaps and future opportunities

While there is a large base of industries in the district, several structural constraints limit the sector's ability to grow, generate employment, and transition toward low-carbon production. At the same time, strong locational and resource advantages create clear pathways for future industrial development.

Table 17: Key gaps and opportunities of industry sector

Key Gaps	Opportunities
1. Limited job opportunities generated by existing industries 2. Constant and stagnant GDP contribution of the industrial sector 3. High dependency on fossil fuels for industrial energy needs	1. Strong agriculture and horticulture base enabling value-addition industries – expansion of agro-processing, marine processing and packaging units can significantly increase local employment. 2. Port-linked industrial growth opportunities – leveraging Jaigad Port for logistics-led manufacturing, export-oriented units and clean light industries can diversify and expand industrial output. 3. Strong potential for aggregated renewable-energy adoption – shared solar/wind PPAs, rooftop solar and group-captive systems for MSMEs can reduce energy costs and decarbonise operations.

B. Low carbon and climate resilient strategies

The following carbon neutral and climate resilient strategies are proposed. Implementation will be led by the Industry Department, with support from relevant municipal and state agencies.

Table 18: Low carbon and climate resilient strategies for industry sector

Sr No.	Strategy priority	Key actions	Indicators	Relevant schemes
1.	Solarisation of industrial estate areas	- Mandate district-wide adoption of solar/renewable energy for estate-level utilities such as streetlighting, water pumping, CETPs, and common facilities. - Facilitate rooftop solar tenders for large and small industrial buildings through group-captive/industrial solar models. - Encourage industrial associations to adopt shared RE procurement frameworks.	Number of estates solarised Annual kWh savings/RE generation	Maharashtra Energy Development Agency (MEDA) Maharashtra State Electricity Distribution Company Ltd. (MSEDCL)
2	Agro & horticulture-based value-addition industries			
2.1	Establish district agriculture and allied food processing & value-addition zones	- Identify and notify agri-horticulture clusters for mango, cashew, kokum, spices, and marine products. - Provide common facilities such as cold storage, boiler, dryers, packaging units and quality testing labs. - Enable simplified clearance pathways for micro and small processing units.	Number of clusters identified number of common facilities operational	MIDH PMFME scheme State Industrial / Solar Energy Policies (including Solar Rooftop & Group Captive / Industrial Solar Policy)
2.2	Promote low-carbon	- Promote solar dryers and steam generators, biomass briquette boilers, electric boilers, and other low-carbon	- Number of processors	MIDH PPP model

	processing technologies	technologies for processing mango, spices, fish, and cashew. - Blend available subsidies for efficient equipment under State/Central schemes.	adopting low-carbon technologies - Tonnes of CO_2 avoided	MSME ministry NMSA
2.3	Strengthen market access via port & logistics integration	- Collaborate with Jaigad Port to enable export logistics for mango, cashew, and marine products. - Develop logistics hubs for load consolidation, grading, packing, and cold-chain management to lower transport emissions.	- Number of export linkages established - Number of logistics hubs developed	- Ministry of Ports, Shipping and Waterways (MoPSW) - APEDA Agricultural & Processed Food Products Export Development Authority
3	Port-linked low-carbon industrial growth			
3.1	Promote green industrial zones near ports	- Identify and notify green industrial zones for low-carbon sectors such as cold-chain, food processing, seafood processing and coir manufacturing. - Provide single-window facilitation for port-linked units to reduce operational delays. - Introduce district guidelines that prioritise renewable energy uptake and energy efficiency for port-adjacent industries.	- Number of zones notified number of industries adopting RE/EE norms	-MIDC -MEDA -MSME ministry - Rooftop Solar & Industrial Estate Solar Scheme / State Industrial Solar Policy
3.2	Develop green logistics corridors from port to industrial clusters	- Establish clean logistics corridors from port to major industrial clusters using dedicated lanes, EV cargo incentives, and improved last-mile efficiencies. - Promote adoption of EV cargo fleets and low-emission transport modes through district-level incentives.	- % of logistics on clean transport - Number of EV/low-emission cargo vehicles	-MoPSW - Ministry of Road Transport and Highways (MoRTH) -MIDC -PPP model

			operating	

While these sectoral strategies lay the foundation for a low-carbon and climate-resilient Ratnagiri, resilience also depends on strong disaster preparedness systems and the conservation of critical ecosystems. The subsequent sections therefore outline the district's Disaster Risk Reduction (DRR) approach and its nature-based conservation priorities.

2.2 Disaster risk reduction

Ratnagiri's diverse geography—stretching from steep Western Ghats slopes to an extensive 167-km coastline—exposes the district to multiple climate-induced hazards, including floods, landslides, storm surges, and shoreline erosion. Recent climate trends indicate a rise in extreme rainfall events, greater monsoon variability, increasing temperatures and increasing frequency of flash-flood conditions across major river basins such as the Vashishti, Shastri, and Jagbudi. Projections under mid-century climate scenarios also suggest a further intensification of rainfall and slope instability risks.

In upland talukas such as Khed, Chiplun, and Sangameshwar, unregulated construction, hill-cutting, and loss of vegetation have heightened susceptibility to landslides. In contrast, low-lying coastal settlements face recurrent flooding, saline intrusion, and infrastructure damage during high-tide and storm events. These multi-hazard pressures underline the need for climate-responsive planning, risk-sensitive land management, and resilient infrastructure development.

Ratnagiri's District Disaster Management Plan (DDMP) already provides a strong foundation for preparedness, early warning, and emergency response. Building on this, the present plan introduces a climate-informed perspective that emphasizes risk prevention, nature-based mitigation, long-term resilience, and alignment with development programmes. It strengthens the DDMP by:

- Integrating updated hazard assessments, climate projections, and risk information into planning and zoning decisions;
- Prioritising ecosystem-based and low-carbon solutions for disaster risk reduction; and
- Linking DRR strategies with livelihood schemes, resilient infrastructure investment, and climate adaptation actions.

Together, this approach shifts the district from reactive disaster response to a proactive model of climate-resilient risk management. The following strategies will be implemented alongside the strategies in the disaster management plan. Implementation will be led by the Disaster Management Department, with support from relevant municipal and state agencies.

The Kokan Mitigation Project is the major scheme/project in Ratnagiri under which these interventions can be supported.

Table 19: Disaster risk reduction strategies for the district

S. No	Strategy priority	Key actions	Indicators
1	Ecosystem-based disaster risk reduction (Eco-DRR)	- Map and designate mangrove, wetland, and backwater zones protecting villages as Eco-DRR zones under DDMP. - Prioritise restoration and protection of degraded mangrove and wetland patches through community stewardship, with support from the forest and fisheries departments (link to carbon credit projects). - Integrate Eco-DRR zones into local development plans, ensuring construction setbacks and regulated land use in these natural buffer areas. - Train and equip coastal communities and SHGs to maintain, monitor, and replant mangroves or wetland vegetation after high-tide or storm events.	Eco-DRR zones notified Area restored SHGs trained
2	Climate-safe housing & basic infrastructure (especially in high-risk villages)	- Integrate climate risk screening into public infrastructure projects. - Upgrade basic infrastructure—all-weather access roads, stormwater drains, slope protection, and cyclone/flood shelters - Retrofit schools and health centers as emergency shelters.	No. of resilient houses built (or upgraded) for vulnerable households No. of high-risk villages with upgraded infrastructure

		- Prepare village-level climate-resilient habitation plans for high-risk villages (flood, landslide, coastal erosion) - Construct multi-hazard-resilient houses with raised plinths, flood/wind-resistant structural design, and safe siting for vulnerable households.	
3	Define NO-GO areas	-Identify "No-go areas", locations with extremely high, unmitigable hazard exposure where development is prohibited or severely restricted.	Area of declared NO-GO zones
4	Flood and river basin management	- Integrate river flood modeling (RCP scenarios) into land-use zoning and infrastructure planning. - Demarcate floodplain buffers along vashishti, shastri, and jagbudi rivers. - Construct and maintain urban and peri-urban drainage systems using nature-based designs (bio-swales, wetlands).	Number of talukas using climate-informed zoning
5	Landslide risk mitigation	- Use landslide-susceptibility maps for zoning and infrastructure siting. - Restrict construction and quarrying in high-susceptibility zones. - Stabilize slopes through bioengineering and afforestation with deep-rooted native species.	% infrastructure screened number of no-construction zones notified
6	Coastal zone and shoreline management	- Integrate Coastal Vulnerability Index (CVI) and shoreline change data into district land-use planning. - Prioritise protection and restoration of high-risk stretches such as Velas, Kelashi, Aade, Anjarle, Harnai, Guhagar, Palshet, Velneshwar, and Jaigad.	Km of high-risk shoreline protected or restored using eco-engineered solutions

		- Implement eco-engineered coastal defense measures (mangrove belts, dune stabilisation vegetative buffers) to reduce erosion and wave impact.	

Box 5: Odisha's climate-resilient housing model

Odisha provides one of India's strongest examples of large-scale climate-resilient housing and settlement planning in high-risk coastal districts. After Cyclone Phailin (2013) and Cyclone Fani (2019), the Government of Odisha implemented the Odisha Disaster Recovery Project (ODRP) with World Bank support.

Key features:

i. 20,000 multi-hazard-resilient houses were constructed in the cyclone-prone districts of Ganjam, Puri, and Khordha.

ii. Houses were designed with:
   - Elevated plinths for flood protection
   - RCC frames for high-wind resistance
   - Safe rooms for extreme events
   - Proper setbacks and safe siting away from erosion zones

iii. The programme included settlement-level planning, not just housing—covering internal roads, drainage, water points, and safer community infrastructure.

iv. Odisha's model has since been recognised by UNDP and the World Bank as a best-practice example of climate-resilient rural housing and has significantly reduced losses during subsequent cyclones and floods.

Source: World Bank. "World Bank Approves Support for Odisha Disaster Recovery Project." World Bank, 21 Feb. 2014, https://www.worldbank.org/en/news/press-release/2014/02/21/world-bank-approves-support-odisha-disaster-recovery-project

2.3 Ecosystem conservation and carbon stewardship

Ratnagiri envisions its ecosystems — forests, mangroves, wetlands, and biodiversity corridors as living carbon assets, sustaining biodiversity, strengthening community livelihoods, and driving the district's transition toward carbon neutrality and climate resilience. Together, these ecosystems form the ecological foundation of Ratnagiri's carbon-neutral development pathway, contributing significantly to both emission offsets and adaptive resilience. Effective conservation and sustainable management of these natural systems are therefore central to achieving the district's climate and development goals.

Table 20: Carbon sequestration potential of the district

Carbon pool / land use	Area (ha)	Estimated sequestration (t CO_2 ha^{-1} yr^{-1})	Potential (Mt CO_2 yr^{-1})
Forest biomass (dense + open) and tree cover	429623	0.5 – 5	0.4 - 0.9 (breakup in Table 21)
Rangeland / grassland	376 324	1.0 – 2.0	0.38 - 0.75
Cropland (soil carbon enhancement)	13 818	0.7 – 1.5	0.01 - 0.02
Mangroves & wetlands	20,979	6 – 8	0.12 - 0.16
Total district natural sequestration potential	-	-	1.0 - 1.8 Mt CO_2 yr^{-1}

Ratnagiri's natural systems already offset 10–20% of its annual emissions (7.8 Mt CO_2/yr). With improved management, the district can move significantly closer to carbon neutrality by 2040.

Box 6: Forest carbon sequestration potential

Ratnagiri's forests cover nearly half the district and include a mosaic of state-managed, private, and community lands interspersed with mango–cashew horticultural belts. The high proportion of privately-owned forests creates both stewardship opportunities and management challenges. While dense forests remain ecologically strong, open forests and scrublands show partial degradation but also offer large potential for restoration and carbon sequestration. District-level estimates based on Forest Survey of India and land-use data are summarised below. Khed and Lanja hold the largest contiguous forest tracts and highest restoration potential, while coastal talukas (Guhagar, Rajapur, Ratnagiri) require focused conservation of coastal forests, riparian belts, and sacred groves (Annexure 5).

Table 21: Forest carbon sequestration potential of Ratnagiri

Forest type	Area (ha)	Sequestration rate (tonnes CO2/ha/yr)	Min CO_2 (t/yr)	Max CO_2 (t/yr)
Very dense forest	3,542	3-5	10,626	17,710
Moderate dense forest	1,92,221	1.5-3	2,88,331	5,76,663
Open forest	2,33,454	0.5-1.5	1,16,727	3,50,181
Scrub	406	0-0.5	0	203
Total carbon sequestration potential (forest)			4,15,684	9,44,757

Source: iFOREST analysis

Box 7: Mangroves and wetlands (Blue carbon)

Ratnagiri's 2,100 ha of mangroves along estuaries such as Jaigad, Mirya, Rajapur and Pawas have shown a steady increase in area due to protection measures and natural regeneration. With sequestration rates of 6–8 t CO_2/ha/yr, current annual mangrove sequestration is 0.012–0.02 Mt CO_2. Beyond carbon benefits, mangroves provide crucial shoreline protection, fish nursery habitats, and flood buffering. The district has moved from decline → stabilisation → recovery. Priority now is community-based monitoring, blue-carbon management, and protection from encroachment/aquaculture expansion.

Table 22: Mangrove trends

Year	Mangrove Area (sq. m)	Area (ha)	Change (ha)	Observation
1996	20887131	2089	-	Baseline coverage (pre-ICZM)
2010	19951194	1995	-94	Slight decline (urban and aquaculture expansion)
2015	19843108	1984	-11	Stabilization phase. Supported by protection measures from the State Mangrove Cell (since 2012)
2017	20099091	2010	+ 26	Early recovery phase
2020	21010109	2101	+ 91	Clear increase (+ 5.8 % since 2015)

Source: Global mangrove watch (1996 - 2020) version 3.0 dataset

Wetlands and backwaters such as Arrey and Pawas are vital for hydrology, sediment balance, flood moderation, and micro-climate regulation. As per the National Wetland Atlas (2010), Ratnagiri hosts 771 wetlands covering 20,979 ha (2.56% of district area) and aquaculture occupies just 46 ha (0.22%), showing limited but growing pressure.

A. Low carbon and climate resilient strategies

The following strategies outline a roadmap to strengthen natural carbon sinks, improve ecological integrity, and integrate ecosystem management with sustainable livelihoods.

Table 23: Low carbon and climate resilient strategies for ecosystem conservation and carbon stewardship

Sr. No	Strategy priority	Key actions	Indicators
1	Community forest carbon stewardship	- Map privately and community-owned forest and horticultural holdings suitable	- Area mapped; Area enrolled in carbon projects

	and market integration	for voluntary carbon projects (VCS/ART/REDD+ smallholder) - Develop community carbon plans through Joint Forest Management Committees (JFMCs), SHGs, and Farmer Producer Organisation (FPOs). - Register at least 5,000 ha under voluntary carbon projects by 2030 (with minimum 60% to landowners).	- Community Carbon Plans prepared - Annual CO_2 sequestered
2	Forest landscape restoration	- Restore degraded open and scrub forests using native, multi-tier species. - Promote bamboo and vetiver for slope stabilisation and erosion control.	Area restored
3	Sustainable eco-tourism and zero-waste forest economy	- Promote eco-lodges, homestays, and trekking routes under 'zero waste' and low-carbon guidelines. - Develop and implement a Green & Zero-Waste Certification Scheme for tourism enterprises, forest trails, and heritage sites. - Establish waste segregation and composting hubs in 20 forest-village clusters. - Ban single-use plastics and promote bamboo and leaf-based alternatives via SHGs/FPOs in all forest- and eco-tourism sites by 2027. - Prepare waste management plans for tourist areas.	- Number of waste management plans prepared - Reduction in plastic waste
4	Forest fire and invasive species management	- Strengthen early-warning systems and fire-lines in fire-prone zones. - Develop community-led fire management task forces through JFMCs. - Undertake eradication and control of invasive species. - Reforest cleared areas with native fire-resistant species.	- Area freed from invasive species - Personnel trained - Reduction in forest fire
5	Mangrove and blue carbon stewardship	- Promote community-based protection of mangrove and estuarine ecosystems through fisher cooperatives, SHGs, and coastal biodiversity committees in 8 major estuaries by 2030. - Establish local monitoring and awareness programmes on mangrove conservation and blue carbon potential in villages (close to mangroves) by 2030 - Encourage eco-friendly aquaculture that	- Ha of mangroves restored - Annual blue carbon gain

		avoids mangrove encroachment and maintains estuarine quality.	
6	Wetland and Backwater Rejuvenation	- Identify and notify key wetlands and backwater systems under the Wetlands (Conservation and Management) Rules, 2017. - Undertake periodic desilting, pollution control, and catchment vegetation management to maintain ecological health. - Integrate wetland management into district land-use and watershed planning frameworks.	- Wetlands notified - Rejuvenation plans implemented - Water retention improvement
7	Biodiversity Corridors and Landscape Connectivity	- Identify and notify 3 ecological corridors linking Western Ghats forests to mangrove/coastal ecosystems by 2027. - Reforest riparian buffers and degraded slopes with native species along these corridors. - Strengthen local biodiversity governance by supporting active BMCs and updating digital People's Biodiversity Registers (PBRs). (*Establishing and strengthening BMCs and maintaining PBRs is a legal requirement under India's Biological Diversity Act (2002) and Rules (2004))	- PBRs updated

Chapter 3: Five-Year Implementation Roadmap (2026–2030) and alignment with Strategic Plan

This chapter integrates short-term climate actions priorities in the District strategic plan. These actions translate overarching goals into implementable, 5-year targets tailored to Ratnagiri's ground realities.

3.1 Agriculture

Agriculture and horticulture are the backbone of Ratnagiri's economy and livelihoods, but are highly climate-sensitive, facing erratic monsoons and rising temperatures. The 2026–2030 plan focuses on climate-smart farming practices that enhance water security, crop resilience, and farmer incomes, serving as a foundation for longer-term sustainable agriculture. Key short-term strategies for agriculture are outlined below.

Table 24: Long-term strategies for agriculture sector

Strategic Action	Strategic target	Climate relevance/integration	Key Agencies & Schemes	Budget allocated in Strategic Plan (billion)	Estimated cost for climate intervention (billion)
Scale up micro-irrigation and farm water storage – promote drip/sprinkler irrigation and farm ponds to	- Cover an additional 5,000 hectares (10% increase in irrigated area) under micro-irrigation.	- Use of Solar PV for irrigation	- Department of Agriculture - PMKSY (Per Drop More Crop) (for subsidies) - MGNREGA (for pond works)	-	50

combat rainfall variability.	- Construct 200 small farm ponds for rainwater harvesting.		- KVKs and Agricultural University (for technical support)		
Introduce climate-resilient crop varieties and seeds – deploy salt-tolerant, drought-tolerant, and early-maturing varieties for staples and horticulture.	- Distribute climate-resilient seed kits to 45,000 farmers (25% of farmers) (rice, pulses, vegetables) - Facilitate release of 3 new stress-tolerant crop varieties through the local research station by 2028.	- Addresses salinity ingress, delayed monsoon onset, and shorter growing seasons impacting rice, pulses, and horticulture - Reduces yield variability and crop failure risks under increasing rainfall and temperature variability	-Agriculture Department and KVKs -NFSM and National Initiative on Climate Resilient Agriculture (NICRA)	-	15
Promote crop diversification and intercropping – support double-cropping in paddy fields and intercropping in orchards (for example spices in coconut, pulses/vegetables in mango plantations)	- Adopt climate-smart intercropping on 2,000 hectares (15% of horticulture land) (for example spices in 500 ha of coconut groves) - Enable double cropping on 1,000 ha of suitable fallow or single-crop land by 2030.	- Lowers climate risk from mono-cropping under erratic rainfall and heat stress - Enhances moisture retention and land productivity	-Agriculture and Horticulture Departments - MIDH scheme (for intercropping support) -NFSM for pulses	-	30
Strengthen post-harvest management and value	- Install 10 solar-powered cold storage	- Reduces climate-induced post-harvest losses from heat,	-Department of Agriculture Marketing & Maharashtra	-	40

addition – establish cold storage, processing, and marketing support to reduce climate-induced losses (especially for mangoes and fish catch).	units at major markets or co-ops by 2030 - Set up 4 modern pack-house/value-addition centers (with ripening chambers and packaging) for fruits by 2030.	humidity, and extreme rainfall disruptions. - Improves resilience of agri-value chains during monsoon-related power and transport interruptions.	State Agri Marketing Board, - PM FME and Agro-Processing Cluster schemes (for funding) -MIDH and state horticulture mission (for infrastructure support)		
Increase productivity of old mango orchards	Rejuvenation of large old mango orchards by following good management practices	- Use climate-resilient mango varieties for replanting - Introduce pest/disease forecasting systems to anticipate climate-driven outbreaks - Study the impact of rising heat on mango flowering to guide adaptive orchard practices.	Horticulture department	60	6 (10%) – *Moderate climate relevance*
Promotion of mango export	Develop pre-harvest and post-harvest practices (SOPs) for the export of mangoes as well as for the domestic market. Mass Campaign for Control of fruit flies for production of fruit fly-free mangoes which affect the export/Quarantine pests.	Invest in climate-controlled post-harvest infrastructure – for example solar-powered cold storage and packhouses – to protect fruit quality. Use low-carbon packaging materials and adjust harvest timing/storage based on weather	Horticulture department	92.5	9.3 (10%) – *Moderate relevance*

		forecasts to avoid heat or moisture damage.			
Human resource development in rejuvenation/grafting/processing/export or orchard management	Workshops/trainings/exposure visits/demonstrations. Masters' trainers and resource persons need to be created through HRD.	Build farmer capacity on adaptive orchard management – include modules on managing climate risks (drought, heat) in mango/cashew orchards. Train master trainers in climate-linked pest surveillance, water-efficient practices, and climate-smart harvesting techniques	Agriculture department	25	2.5 (10%) – *Low–moderate relevance*
Reduction of post-harvest losses	Reduction of post-harvest losses by: 1. Establishing ripening chambers 2. Grading and packaging 3. Grade processing.	Upgrade facilities to energy-efficient, climate-proofed systems – for example use renewable energy-powered cold chains, insulated ripening chambers, and improved packaging that preserves quality under higher temperatures. Train farmers in techniques to reduce heat-related spoilage during storage and transit.	Agriculture department	10	1.5 (15%) – *High relevance*
Promotes intercropping to	Promotes intercropping (of vegetables, pulses, etc.) in juvenile mango	Apply soil moisture conservation methods (mulching,	Agriculture department	6 (1+5)	0.6 (10%) – *Moderate relevance*

increase farmer income	and cashew plantations to increase farmer income; Intercropping of spices crops in coconut for example Lakhe bagh	shaded intercrops) to protect intercrops during dry spells. Provide micro-irrigation support and rainwater harvesting for intercrops and choose intercrop varieties that are tolerant to shade and heat.			
The practice of double cropping	1. With proper water management 2. Construction of low-cost water structures 3. Protective irrigation for rabi crops	Ensure protective irrigation for the rabi crop – build *low-cost water storage* (farm ponds) and promote drip irrigation to maximize water use. Use drought-tolerant crop varieties and provide weather-based advisories so farmers can adjust planting to monsoon timing.	Agriculture department	2	0.3 (15%) – *High relevance*
Increase area under irrigation	Increase area under irrigation by promoting vegetable cultivation	Improving irrigation infrastructure is a key climate adaptation in water management	Agriculture department	22.5	4.5 (20%) – *Very high relevance*
Group farming/community farming	Bring fallow land into cultivation	Identify suitable climate-resilient crops for fallow lands (for example hardy millets, fodder). Introduce salinity and heat tolerant crop varieties for fallow coastal	Agriculture department, FPOs	150	0.5 (5%) – *Low relevance*

		lands. Pilot agro-photovoltaic (Agro-PV) systems on fallow or degraded land – combining solar panels with underneath cropping – to utilize land while generating clean energy.			
Mechanisation in paddy cultivation	Mechanisation in paddy cultivation includes nursery, transplanting and harvesting	Farm mechanisation is a general productivity measure with minimal direct climate impact (aside from potential efficiency gains)	Agriculture department	9	0.5 (5%) – *Low relevance*
Quality seed production	Enhance R&D at local rice research station for seed supply	Focus R&D on stress-tolerant seed varieties – for example rice strains that withstand salinity or flooding. Establish community seed banks for climate-resilient seeds to ensure farmers have access to suitable varieties in adverse seasons.	Agriculture department	5	0.8 (15%) – *High relevance*
Total Budget	161.5				

3.2 Energy

The energy strategy for Ratnagiri over 2025–2030 focuses on expanding renewable energy and improving energy efficiency to set the district on a low-carbon path. As a coastal district with high solar potential, Ratnagiri can achieve quick gains through solar installations, while improving grid resilience in the face of extreme weather. Key short-term energy actions include:

Table 25: Long-term strategies for energy sector

Strategic Action	Strategic target	Climate Integration/relevance	Key Agencies & Schemes	Budget allocated in Strategic Plan (crores)	Estimated cost for climate intervention (crores)
Accelerate renewable energy deployment – install solar power systems (rooftop and ground-mounted) for institutions, farms, and communities.	Add 500 MW of new solar capacity in the district by 2030through private sector investment Install 10 MW of rooftop solar with battery storage on government buildings and schools.	- Supports low-emission development by displacing fossil-fuel–based electricity generation. - Enhances energy security in a climate-vulnerable coastal district prone to grid disruptions during extreme weather.	- Mukhyamantri Saur Kranti Yojana, central Rooftop Solar Programme. - MEDA and MSEDCL - implementing through state solar schemes, and PPP models.	-	50
Solarise agriculture and villages – promote solar pumps for irrigation and	Deploy 3000 solar water pumps in farms by 2030(reducing diesel pump use by 30%)[33]	- Reduces dependence on diesel pumping, lowering emissions and exposure to	- Zilla Parishad and Maharashtra State Electricity Distribution Co.	-	20

solar lighting in rural areas.	Install solar LED streetlights across 50% of villages by 2030.	fuel price volatility. - Ensures reliable energy access for irrigation and lighting during power outages linked to storms and heavy rainfall.	- Solar pumps via PM-KUSUM and state programs, - Solar streetlights via the Village Panchayats with funds like Sansad Adarsh Gram Yojana or state rural LED initiatives.		
Enhance energy efficiency in lighting and appliances – roll out LED bulbs, energy-efficient appliances, and smart meters to reduce energy demand.	Achieve 100% LED lighting in all public buildings and streetlights by 2025 and distribute LED bulb kits to all households (targeting complete swap-out of incandescent/ CFL bulbs by 2030).	- Lowers overall electricity demand, reducing peak load stress during heatwaves. - Delivers cost-effective emissions reduction while improving resilience of the local power system.	- District Administration and MSEDCL, under the UJALA program (Unnat Jyoti by affordable LEDs for All)	-	5
Improve grid resilience and backup power – strengthen electricity distribution infrastructure and provide backup systems for critical facilities (for example	Climate-proof 50 km of power lines in coastal/high-wind areas by 2030 (through underground cabling or resilient poles) and equip all primary health centers with solar-	- Reduces power disruption risks from cyclones, high winds, and coastal weather extremes. - Ensures uninterrupted electricity	- MSEDCL with support from State Disaster Mitigation funds for critical infrastructure protection.	-	20

solar+storage for health centers).	battery backup by 2027.	supply for health and emergency services during climate-induced disasters.			
Develop repurposing plan for the gas fired power plant	- Undertake phased techno-economic assessment for repurposing the plant into renewable/industrial use (solar park, green hydrogen, industrial zone).	- Enables planned transition away from fossil fuel infrastructure in line with long-term decarbonisation pathways. - Avoids future stranded assets while supporting climate-compatible economic use of existing industrial land.	-Mahagenco - PPP	-	*3*
Total Budget	**98**				

3.3 Fisheries

Fisheries – including marine fishing, brackish aquaculture (shrimp), and inland fish farming – are vital to Ratnagiri's coastal communities and economy. However, climate change is impacting fish stocks and exposing fisherfolk to greater risks. The five-year plan prioritizes making fisheries more resilient and sustainable through modern practices and risk reduction. Key actions for 2026–2030 include:

Table 26: Long-term strategies for fisheries sector

Strategic Action	Strategic target	Climate Integration	Key Agencies & Schemes	Budget allocated in Strategic Plan (crores)	Estimated cost for climate interventi on (crores)
- Promote climate resilient aquaculture - Introduce open-sea cage culture and improve coastal aquaculture with resilient infrastructu re	- Deploy 50 open-sea fish cages with cyclone resilient HDPE cage design (a pilot) by 2027 - Establish 1 new brackish-water shrimp hatchery with climate-smart technology by 2030.	- Adapts aquaculture systems to rising sea temperatures, salinity changes, and cyclone risk along the Konkan coast. - Reduces climate vulnerability of near-shore aquaculture by shifting to offshore and climate-resilient infrastructure.	-Department of Fisheries -CMFRI and CIFE (for technical know-how) -PMMSY (has components for new hatcheries, cage culture)	-	50
- Modernise fishing vessels for efficiency and safety upgrade the fishing fleet	- Retrofit or replace engines on 500 fishing boats (20% of mechanised	- Reduces fuel consumption and emissions from fishing operations while improving	-Department of Fisheries -PMMSY - support by Fishermen's Cooperative Societies	-	15

with fuel efficient engines and safety equipment (early warning systems, GPS, life vests)	boats) with fuel-efficient models by 2028, - Equip 100% of active fishermen (14,000)[34] with GPS and safety kits by 2025 (along with enrolment in SMS weather alert services).	economic resilience. - Enhances fisher safety and adaptive capacity through early warning access during extreme weather and rough sea conditions.			
- Strengthen cold chain and processing for fishery - Set up energy-efficient cold storage, ice plants, and fish processing units at landing centers to reduce post-harvest losses.	- Establish 3 solar-powered ice plants/cold rooms at major fish landing sites (Harbors or co-ops) by 2027 - Ensure 50% of fish catch undergoes cold-chain handling by 2030 to maintain quality	- Minimises climate-induced post-harvest losses caused by rising temperatures and disrupted landings during extreme weather. - Improves resilience of fishery value chains to monsoon variability and storm-related power disruptions.	-Department of Fisheries and District Industries Centre (DIC) - PMMSY - Marine Product Export Development Authority (MPEDA) schemes -Fisheries Co-operative Societies	-	15
- Livelihood diversificati on and skill training – train fisherfolk	- Train 5,000 (30% of active fisherfolk) individuals, with at least	- Reduces livelihood dependence on increasingly climate-vulnera	- District Fisheries Dept - Maharashtra Centre for Entrepreneurs	-	5

(including women) in alternative livelihoods (ornamental fish farming, eco-tourism, fish processing) to reduce reliance on climate-vulnerable fishing.	30% women, in climate-resilient livelihoods (ornamental fish culture, tourism, value-added products) by 2030 - Establish 5 community enterprises (for example dried fish, artisanal products) by 2028.	ble marine capture fisheries - Builds adaptive capacity of fishing communities, including women, to cope with declining fish stocks and weather-related fishing disruptions	hip Development - MSRLM and NFDB - PMMSY		
Increase marine fish production	Open sea cage culture program to boost marine fish production; Upgradation of fishing harbours & infrastructure development.	Adopt cyclone-resilient cage designs (HDPE cages with secure moorings) and establish protocols to retrieve or secure cages ahead of extreme weather. This minimizes damage and stock loss during cyclones, ensuring the program's sustainability under harsher climatic conditions.	Fisheries department	5.05	1.01 (20%) – *High relevance*
To increase capture	Sea ranching	Integrate habitat	Fisheries department		

fisheries production.	program – breed and release fish seed to enhance capture fisheries.	restoration: pair sea ranching with mangrove and coral reef restoration to improve breeding grounds. Use broodstock selected for temperature tolerance to ensure released juveniles thrive.			
Increase deep-sea production	Increase deep-sea production by deep sea fishing	Encourage a low-carbon approach: provide fuel-efficient engines or support engine retrofits for deep-sea vessels to reduce fuel use. Pilot hybrid propulsion	Fisheries department	10	0.5 (5%) – *Low relevance*
Increase shrimp production	Establish a shrimp hatchery center – boost brackish water shrimp production	Design the hatchery for climate-smart aquaculture: use energy-efficient aerators and consider RE to power operations. Practice zoning – locate the hatchery and shrimp farms away from ecologically sensitive mangroves and estuaries to avoid habitat loss. Incorporate better	Fisheries department	15	2.25 (15%) – *High relevance*

		management practices that limit water pollution and promote disease resilience.			
Increase freshwater aquaculture fish production; Increase ornamental and food fish production	Training for freshwater fish farming – support fish farmers and women's groups in rearing ornamental and food fish.	Introduce Recirculating Aquaculture Systems (RAS) and temperature-controlled units for inland fish culture to deal with erratic weather. Provide market linkage training to diversify markets (for example ornamental fish export), which reduces economic vulnerability if local yields fluctuate. Emphasize low-cost cooling or aeration techniques to protect tank fish during heatwaves.		45.5 (22.75+22.75)	4.55 (10%) – *Moderate relevance*
Total Budget	**94.31**				

3.4 Buildings and Infrastructure

This sector addresses buildings, transport links, and other infrastructure, integrating climate resilience and low-carbon measures into the district's development projects. Given Ratnagiri's vulnerability to heavy monsoons, flooding, and landslides, new construction and retrofits must be climate-proofed. The 2026–2030 roadmap emphasizes resilient design, green building practices, and sustainable mobility:

Table 27: Long-term strategies for building and infrastructure sector

Strategic Action	Strategic target	Climate Integration/relevance	Key Agencies & Schemes	Budget allocated in Strategic Plan (Crores)	Estimated cost for climate intervention (Crores)
Adopt climate-resilient building standards – integrate updated design guidelines (flood, wind, and earthquake safety) into all new construction and retrofits.	- Incorporate climate-resilient design codes into 100% of new public buildings by 2025 - Retrofit all critical structures (hospitals, schools) with flood-proofing and roof reinforcement by 2030.	- Reduces structural damage and service disruption from floods, cyclones, high winds, and seismic risk in a multi-hazard coastal district. - Integrates long-term climate risk considerations into public infrastructure planning and asset lifecycles.	PWD and Rural Development Department	-	20
Green and energy-efficient buildings – promote solar rooftops, rainwater	- Equip 100% of government offices and schools with rooftop solar and	- Lowers building-sector emissions while reducing stress on energy and water systems	District Planning Office and PWD	-	25

harvesting, and energy efficiency in buildings.	rainwater harvesting systems by 2030 - achieve 5 certified green buildings (rating-compliant) in the district by 2028.	during heatwaves and dry spells. - Enhances self-reliance of public buildings during climate-induced power and water -supply disruptions.			
Climate-proof roads and bridges – upgrade transportation infrastructure to withstand heavy rainfall, floods, and erosion, while reducing emissions.	- Reconstruct or elevate 50 km of flood-prone roads by 2030 with improved drainage and materials, and strengthen 10 key bridges with climate-resilient designs (higher flood clearance) by 2027. - Install EV charging points at 5 major highways/town stops to encourage electric vehicles.	- Reduces transport disruption and asset damage from intense rainfall, flooding, and soil erosion - Supports low-emission mobility through EV readiness while maintaining connectivity during extreme weather events	-PWD and Maharashtra State Road Development Corporation (MSRDC) - Pradhan Mantri Gram Sadak Yojana (PMGSY)	-	50

Enhance urban flood management – expand stormwater drainage, nature-based solutions, and emergency preparedness in flood-prone towns.	- Construct/ upgrade 20 km of stormwater drains in Ratnagiri, Chiplun and other flood-prone towns by 2028 - Implement 3 pilot nature-based projects (for example mangrove restoration, urban wetlands) for flood absorption by 2030.	- Addresses increasing frequency and intensity of urban flooding due to extreme rainfall events. - Uses nature-based solutions to absorb floodwaters and reduce pressure on grey drainage infrastructure	Urban Local Bodies - Mangrove Cell for nature-based projects such as mangrove restoration	-	30
Improving communication by improve road connectivity	Build new district roads and village roads to strengthen communication links.	Incorporate climate-resilient road design: use elevated embankments and adequate drainage to prevent flooding and erosion damage. Utilize low-carbon materials (fly-ash bricks, recycled aggregates) in construction. Line road corridors with vegetation to stabilize soil	- Urban local bodies and PWD	284.9	42.73(15 %) – *High relevance*

		and sequester carbon.			
Improving communication by strengthening footbridges	Upgrade rural footbridges (Sakav) – construct new footbridges and repair old ones for all-weather rural connectivity.	Design climate-resilient footbridges by raising bridge heights and using rust-proof materials to withstand higher flood levels and intense rainfall. In repairs, retrofit bridges to resist washouts during extreme weather.	- Urban local bodies and PWD	36.45	5.46 (15%) – *High relevance*
Improving communication by strengthening bridges	Strengthen bridges – enhance the capacity and safety of existing bridges on roads.	Climate-proof bridge structures by factoring in future flood flows and storm surge in design. Implement routine inspections and maintenance with a climate lens (checking for flood-induced scouring, etc.), thus extending bridge life under	- Urban local bodies and PWD	17.15	2.57 (15%) – *High relevance*

		changing conditions.			
Total Budget	175.76				

3.5 Industry

Ratnagiri's industrial base (food processing, port-linked industry, MSMEs) and livelihood programs must align with a low-carbon, climate-resilient trajectory. In the next five years, the focus is on greening industrial growth (especially around ports and processing zones) and building climate awareness into employment schemes. Key strategies include:

Table 28: Long-term strategies for industry sector

Strategic Action	Strategic target	Climate Integration/relevance	Key Agencies & Schemes	Budget allocated in Strategic Plan (Crores)	Estimated cost for climate intervention (Crores)
Promote clean energy and efficiency in industries – encourage industries (especially MSMEs like cashew and mango processing) to adopt renewable energy and energy-efficient technologies.	At least 20 industrial units adopt solar power or biomass energy by 2027 (cumulative 10 MW installed) and conduct energy audits for 50 MSMEs by 2025 with follow-up	- Reduces industrial emissions while lowering exposure to rising energy costs and grid disruptions during extreme weather. - Improves resilience of agro-processing MSMEs to power unreliability.	DIC and MIDC with support from MEDA	-	10

	retrofits to cut energy use by 20%.				
Develop a "Green Industrial Zone" pilot – plan a low-carbon industrial park (for example near Jaigad/Dabhol port) with shared renewable energy, waste management, and climate-resilient infrastructure	Draft a Green Industrial Zone plan by 2025 and initiate development of one pilot green industrial estate by 2030 (with >50% renewable energy use and climate risk measures)	- Enables planned low-emission industrial growth aligned with long-term decarbonisation pathways. - Integrates flood, cyclone, and heat-risk considerations into industrial siting and infrastructure design.	MIDC	-	10
Green skills and jobs program – integrate climate and clean-tech skills into employment schemes (for example youth skill training, entrepreneurship support) to create green jobs.	Train 5,000 youth in climate-friendly skills by 2030 (solar installation, efficient irrigation, agro-processing, etc.) and ensure all entrepreneurship loans under PMEGP	- Builds a workforce capable of supporting climate mitigation and adaptation actions across sectors. - Enhances livelihood resilience by creating employment linked to the green and low-carbon transition.	-District Skill Development Committee - PMKVY (for youth training) -Deen Dayal Upadhyaya Grameen Kaushalya Yojana (DDU-GKY) (for rural youth and entrepreneurship schemes)	-	10

	include an option for green enterprises or climate adaptation projects.				
Improve industrial hazard resilience – require climate risk assessments and emergency response plans for industries, especially in flood or cyclone-prone areas.	100% of large industries in Ratnagiri prepare climate risk management plans by 2027, and conduct annual drills for industrial disaster response (flood, cyclone, chemical leak) in all major industrial clusters	- Reduces risks of industrial accidents and service disruptions during floods, cyclones, and extreme rainfall events. - Strengthens preparedness of industrial clusters for climate and technological hazards.	District Disaster Management Authority (DDMA) and Maharashtra Industrial Safety and Health Department	-	2
Employment generation	Employment generation programs (for example Chief Minister's Employment Scheme, PMEGP) to create jobs and support micro-enterprises.	Integrate green skills and enterprises into these programs. Provide training in solar installation, energy-efficient equipment, recycling/upcycling, etc., so that new businesses are	District Industries Centre	25	2.5 (10%) – *Moderate relevance*

		aligned with green growth.			
Facilitate entrepreneur development		Include climate adaptation and green-entrepreneurship modules	District Industries Centre	2	0.1 (5%) – *Low relevance*
Total Budget	**34.6**				

** Strategies highlighted in colour represent additional recommendations proposed under this plan. Unshaded strategies are adopted from the existing strategic plan.*

The 2026–2030 roadmap sets out a focused package of short-term climate interventions across agriculture, energy, fisheries, infrastructure, industry, and tourism to strengthen Ratnagiri's resilience and advance its low-carbon transition. Key actions include scaling micro-irrigation, resilient seeds, orchard rejuvenation, diversification, and solar-powered cold storage in agriculture; accelerating solar deployment, rural solarisation, and grid resilience; and initiating repurposing of the gas-based power plant. Fisheries priorities strengthen climate-resilient aquaculture, modernise fishing fleets with safer and fuel-efficient technologies, expand solar-powered cold chains, and diversify coastal livelihoods. Infrastructure actions mainstream climate-resilient building design, upgrade roads and bridges against floods and erosion, expand stormwater systems, and pilot nature-based flood solutions. Industrial actions promote clean energy adoption in MSMEs, develop a pilot Green Industrial Zone, integrate green skills, and enhance climate risk management. Tourism interventions promote eco-tourism, low-impact beach facilities, and climate-resilient tourist infrastructure.

Across all sectors, Ratnagiri proposes a total investment of ₹444.57 crore for 2026–2030—combining dedicated budgets for short-term climate strategies with the climate-relevant share of Strategic Plan allocations. These interventions deliver immediate resilience and mitigation benefits while laying a strong foundation for Ratnagiri's long-term goals of carbon neutrality, climate resilience, and ecosystem stewardship.

The following chapters will detail the mechanisms for implementation, monitoring, and financing to ensure these strategies are realised effectively on the ground.

Chapter 4: Monitoring and implementation

Monitoring and implementation are central to ensuring that this plan moves effectively from strategies to measurable outcomes. Given the range of sectors, agencies, and timelines involved, a structured system helps track implementation, identify gaps early, and ensure accountability across departments. Therefore, it is not only a compliance requirement but a strategic tool for informed decision-making.

The action plan will be anchored within the district administration, with the District Collector serving as the overall authority for guiding, coordinating, and reviewing implementation. In line with the Maharashtra SAPCC framework, the district should establish a dedicated District Climate Cell (DCC) under the Collector's leadership. This Cell will function as the nodal body for coordinating climate-related actions across departments, ensuring integration of climate priorities into routine development work, and facilitating regular monitoring and reporting.

Because there is no district-level Environment Department, the DCC will serve as the district's core climate coordination mechanism. The State Climate Cell will provide technical guidance, capacity support, and policy alignment, but day-to-day coordination and monitoring will remain with the DCC. Through this structure, the district can maintain clear accountability, strengthen inter-departmental collaboration, and ensure effective implementation on the ground.

4.1 Monitoring timeline and review cycle

This monitoring timeline outlines the recommended frequency and review cycle to support timely assessment, accountability, and adaptive management of the action plan. Most strategies fit within a 5-year implementation window, with longer-term actions carried forward into subsequent planning cycles.

Quarterly monitoring: Implementing departments collect indicator data and submit progress updates to the District Climate Cell.

Bi-Annual district review: Chaired by the District Collector to assess implementation status, resolve bottlenecks, and realign inter-departmental coordination.

Annual climate progress report: A consolidated district-wide progress report summarising progress, challenges, and priorities for the upcoming year.

End-term evaluation (end of year 5): Measurement of final outcomes and impacts, documenting lessons to guide the next planning cycle. Long-term interventions requiring continued implementation are carried into the next 5-year plan and aligned with the district's 2040 vision.

Finance-related reporting—including fund utilisation, climate finance mobilisation, and carbon revenue tracking—will be integrated into the annual reviews through the District Climate Finance Platform (DCFP) (explained in chapter 5), ensuring alignment between physical progress and financial performance.

Figure 11: Monitoring and implementation flowchart

4.2 Guidelines to use the framework

The sectoral strategy tables in this plan follow a common structure to ensure clarity, comparability, and ease of monitoring. Each column captures a specific dimension of the action being proposed. The guidelines below explain how to interpret and use each column for planning, implementation, and monitoring.

Sr No.	Strategy priority	Key actions	Indicators	Relevant schemes

1. Strategy priority

This column identifies the broad strategic focus area within the sector. It answers the question: *"What is the major objective or priority intervention for this sector?"* Examples include: Promote Green Industrial Zones Near Ports, Climate-sensitive crop diversification, Ecosystem-Based Disaster Risk Reduction (Eco-DRR) etc. These priorities guide departments in allocating resources and coordinating cross-cutting actions.

2. Key actions

This column lists the specific, measurable activities required to operationalise the strategy. Key actions describe *what exactly needs to be done*, *by when*, and *at what scale*. These are the SMART steps—clear, time-bound, and actionable—such as:

- Restore 150 ha of mangroves by 2030
- Install 10 solar-hybrid cold rooms
- Train 300 community fire volunteers
- Certify all eco-tourism units under green norms

These actions form the basis for annual work plans and departmental action schedules.

3. Indicators

Indicators measure the progress and performance of each strategy. They answer: *"How will we know if this action is working?"*

Indicators track:

- Outputs (number of households covered, hectares restored, units installed)
- Outcomes (reduction in vulnerability, improvement in ecosystem health)
- Efficiency (timeliness, completion rate)

They are essential for quarterly monitoring, annual climate reports, and mid-term evaluation.

4. **Relevant schemes**

To ensure the strategies are practical and immediately implementable, departments should prioritise convergence with **existing Central, State, and district schemes**. Most actions can be supported through ongoing programmes and development schemes.

Departments should:

- Map each key action to one or more existing schemes listed in the framework.
- Use scheme flexibilities and convergence provisions to integrate climate-resilient components without new budget demands.
- Route new or innovative actions through State-level proposals, CSR, or the DCFP for additional support.

This ensures climate action is embedded into routine departmental planning while minimising the need for fresh financial allocations.

Together, these columns provide a simple but powerful framework to translate sectoral strategies into measurable implementation steps. They allow the district to track progress consistently, assess performance, and ensure timely, data-driven decision-making.

4.3 Institutional mechanism for monitoring and implementation

Effective monitoring and implementation require a clear institutional structure that defines who collects data, who validates it, and who makes decisions based on the findings. The institutional mechanism outlines the roles, responsibilities, and coordination pathways between district departments, local bodies, and state agencies. This structure ensures accountability, facilitates timely reviews, and enables course correction throughout the implementation cycle. By clearly assigning responsibilities to each institution, the district can maintain consistent tracking of progress and ensure that climate actions are implemented efficiently and collaboratively.

Table 29: Institutions and their key responsibilities

Institution	Key responsibilities
District Collector	Chairs bi-annual reviews; ensures coordination across departments; approves corrective actions and resource reallocations.
Proposed District Climate Cell (DCC) (to be established under Collectorate)	Coordinate climate-related data collection; validate departmental submissions; maintain dashboards; prepare quarterly and annual progress reports; support district-level reviews; serve as a liaison between district and state climate authorities.
Implementing departments (as per sectoral strategies)	Collect indicator data; implement actions; submit quarterly updates; report delays, gaps, and resource needs. As per the strategies, this may include the Forest Department, Agriculture Department, Fisheries Department, Industry Department and others.
ULBs and Gram Panchayats	Support local monitoring; engage communities; ensure compliance with sectoral measures; provide ground-level data.
State departments	Provide policy alignment; technical guidance; budget convergence; ensure consistency with state-level climate frameworks.

Together, these institutions form a coordinated system for monitoring, reviewing, and guiding the implementation of this plan. The District Climate Cell (DCC) will serve as the overarching coordination body for monitoring and evaluation. The District Climate Finance Platform (DCFP), introduced in Chapter 5, will function as a specialised finance arm working under the guidance of the DCC. This ensures that technical monitoring, financial tracking, and carbon finance functions remain streamlined and avoid duplication.

Chapter 5: Climate finance framework

Climate action requires predictable and diversified financing mechanisms to support implementation across sectors such as agriculture, fisheries, ecosystems, energy, and disaster resilience. While Ratnagiri already mobilises funds through district budgets and centrally sponsored schemes, the scale of investment needed for a climate-resilient and carbon-neutral pathway requires a broader mix of public, private, and market-based finance.

This chapter outlines (a) the current funding landscape, (b) emerging opportunities—especially carbon markets, blended finance, and green instruments—and (c) a proposed financing mechanism to support the District Development cum Climate Action Plan.

5.1 Existing financial mechanisms at the district level

Ratnagiri currently accesses financing for climate-relevant activities through multiple established channels:

1. Centrally sponsored schemes and state schemes

- MNREGA — watershed works, plantations, soil conservation
- NABARD / RIDF — irrigation, watershed, rural infrastructure
- CAMPA — forest restoration, compensatory afforestation
- Fisheries Schemes (Blue Revolution, PMMSY)
- Agriculture Missions (NMSA, PKVY, PMKSY)
- National Health Mission / urban grants (for heat adaptation, services)

Other relevant schemes in the district are:

- Welfare schemes for fishermen
- Reafforestation of de-graded forest scheme
- Works for protection of forest scheme

- Eco tourism scheme
- Wildlife and nature conservation scheme
- Training of Rural Youths for self-employment by TRYSEM and Industrial training institute scheme
- Assistance to MSEDCL Co. Ltd for general development and system improvement scheme
- Electricity distribution company limited for development and system improvement scheme
- Non-conventional energy development scheme
- Schemes for Providing stipends to entrepreneurs for starting enterprise under the Educated un-employment Programme
- Grants to Zilla Parishad for strengthening and development of village roads scheme

2. Line department budgets

Agriculture, Forest, Fisheries, PWD, Energy, ULBs, and Zilla Parishad departments finance routine operations and small-scale climate activities.

3. Disaster management funds (NDRF / SDRF)

Supports early warning, cyclone shelters, and mitigation measures.

4. Corporate social responsibility (CSR)

Private sector (ports, industries, banks, energy companies) funds:

- Mangrove restoration
- Community infrastructure
- Renewable energy in schools/PHCs
- Coastal resilience activities

While these sources fund several climate-relevant activities, they are fragmented across departments and do not follow a unified climate finance strategy — creating a need for a coordinated mechanism.

5.2 Leveraging carbon markets: revenue potential for Ratnagiri

Ratnagiri's natural sequestration potential is estimated at 1.0–1.8 million tonnes CO_2 per year from forests, mangroves, croplands, and other ecosystems. If even 10% of this potential is monetised — through enhancement of sinks and eligible additional activities under voluntary carbon markets — the revenue potential is as follows:

Table 30: Carbon market revenue potential (Assuming 10% Credit-Eligible Sequestration)

Scenario	Price per tCO_2	Revenue potential
Low market price	₹ 300	₹ 30 - 54 million per year
Moderate price	₹ 600	₹ 60 - 108 million per year
High-integrity credits (Blue carbon / Forest FLR)	₹ 1,000	₹ 100 - 180 million per year

Note: India's voluntary carbon market prices typically range from ₹ 300 to ₹ 1,100 per tonne, depending on project type, co-benefits, and verification standards.

Even if only 20–30% of the district's sequestration potential is made market-ready (subject to land eligibility, additionality, and MRV requirements), Ratnagiri could generate approximately ₹200–540 million annually from high-integrity carbon credits.

How Ratnagiri can monetise carbon credits

Community institutions (JFMCs, SHGs, FPOs), Gram Panchayats, Forest Department, Farmers and landowners (agroforestry, soil carbon) can earn through carbon credits. Priority project types that are eligible for carbon markets are:

1. Forest Landscape Restoration (FLR) — large-scale native restoration
2. Agroforestry & Horticulture Carbon Programs
3. Mangrove and Blue Carbon Projects (high value)
4. Soil Carbon Enhancement (croplands + rangelands)
5. Renewable Energy Adoption in MSMEs, buildings, and rural systems
6. Biogas / Biochar / Livestock manure management
7. Wetland restoration and watershed regeneration

Implementation pathway for carbon finance

1. Create a district-level carbon aggregation platform.
   This aggregates farmers, SHGs, JFMCs and fisheries groups. Given fragmented land ownership and smallholder dominance, aggregation is essential for lowering MRV costs, ensuring consistency, and making carbon projects feasible at scale.
2. Register projects with Verra, Gold Standard, ART TREES, or MoEFCC domestic registry
3. Implement monitoring, reporting, and verification (MRV)
4. Issue and sell carbon credits to corporates, PSUs, or state markets
5. Share revenues with communities, Gram Panchayats, and forestry groups

5.3 Other climate finance instruments Ratnagiri can leverage

In addition to district budgets, state schemes, and carbon markets, Ratnagiri can access a diverse set of national and international climate-finance instruments. These instruments offer grants, concessional loans, guarantees, and blended-finance opportunities that can support resilience, ecosystem restoration, energy transition, and coastal protection.

1. Adaptation finance sources

Although international and national adaptation finance—such as the Green Climate Fund (GCF), Adaptation Fund (AF), and National Adaptation Fund for Climate Change (NAFCC)—cannot be accessed directly by Ratnagiri district, they remain important sources that Maharashtra can tap into for large-scale resilience initiatives. Ratnagiri can benefit indirectly through State-led proposals that include district components. Key points are:

i. Funds flow through the state government
   All major adaptation finance mechanisms require proposals to be submitted by MoEFCC, accredited national entities (for example NABARD), or the state government—not by districts.

ii. Ratnagiri can be included in state proposals
   Maharashtra can incorporate Ratnagiri in multi-district adaptation projects focusing on coastal resilience, fisheries adaptation, horticulture, watershed restoration, or Eco-DRR.

iii. Strong justification exists for inclusion
   Ratnagiri's high coastal vulnerability, fisheries dependence, flood–landslide exposure, and

horticulture-based livelihoods make it a strong candidate for State-supported adaptation proposals.

iv. Potential areas of support
If included, these funds can finance:

a. Mangrove & dune restoration
b. Climate-resilient coastal infrastructure
c. RE-based fisheries cold chain
d. Watershed & slope stabilisation
e. Resilient agriculture & agroforestry systems

2. Sovereign green bonds (Central & State)

Green bonds are debt instruments issued by governments to finance environmentally beneficial projects. Maharashtra has already entered this space. Ratnagiri cannot independently issue green bonds but can propose district projects to the state line departments.

Applications for Ratnagiri:

The district can propose shovel-ready projects such as:

- Mangrove/storm-buffer belts
- Climate-resilient coastal and riverine roads
- Solarisation of schools, PHCs, anganwadis
- Low-carbon municipal services (EV garbage fleets, solar STPs, LED retrofits)

Financing type: Government-backed low-cost capital.

3. Multilateral development bank funding

World Bank, ADB, and KfW fund large-scale resilience, water, agriculture, and infrastructure projects. These funds flow through state government departments, not districts directly.

Applications for Ratnagiri:

- Integrated watershed management
- Slope stabilisation and landslide mitigation
- Climate-resilient rural roads
- Climate-smart agriculture and horticulture value chains
- Coastal village resilience and flood-proofing

Financing type: Concessional loans, technical assistance, blended finance.

4. Corporate Social Responsibility & PPP-Based Financing

CSR can fund community-level climate resilience, while Public–Private Partnerships (PPP) bring private capital into long-term infrastructure. This option is highly feasible for Ratnagiri as it can be mobilised at district level. PPP can be anchored through ULBs, Zilla Parishad, or District Collectorate.

Applications for Ratnagiri:

- EV charging hubs
- Decentralised waste management
- Mangrove restoration and coastal resilience
- Renewable-energy-based cold chain systems
- Biochar/biogas units for fisheries and agriculture waste

Financing type: Private capital + CSR grants + PPP viability-gap funding.

5. Payment for Ecosystem Services (PES)

A mechanism where communities or landowners are compensated for protecting ecosystems that provide public benefits (flood control, carbon sequestration, biodiversity, water regulation). Highly suitable because Ratnagiri has large **mangroves, forests, watersheds, and biodiversity-rich zones**. It can be piloted at district and even panchayat level. It works well with community institutions (JFMCs, SHGs, cooperatives).

Application in Ratnagiri:

- Incentives for mangrove protection by fishing communities
- Payments to local groups managing riparian buffers
- Forest fire prevention incentives for JFMCs
- Village-level water-reserve protection and watershed services

Financing type: Performance-based payments.

6. Blue economy finance

Funding dedicated to coastal and marine ecosystems, aligned with national and international blue economy priorities. It is accessible through ministries (MoEFCC, MoF&ARD, MoPSW) or international partners.

Applications for Ratnagiri:

- Coastal ecosystem restoration (mangroves, dunes, mudflats)
- Sustainable fisheries and responsible aquaculture
- Nature-based coastal protection
- Wetland rehabilitation and backwater rejuvenation
- Marine biodiversity protection

Financing type: Grants, concessional loans, blue bonds, blended finance.

BOX 8: Indian Examples of PES

Example 1: Himachal Pradesh – Community PES for watershed services

Villages in Kuhan & Oach (Kangra district) are paid by downstream users for maintaining forest and water sources.

Funded by local water users + state watershed programmes.

Payments are tied to slope treatment, forest protection, and water flow maintenance.

Example 2: Meghalaya – PES for forest & water conservation

The state introduced a PES policy where communities protecting sacred groves and forest patches receive payments.

Payments linked to forest health, water regulation, and biodiversity.

Source:

1. Government of Himachal Pradesh, Department of Forests. (2020). Policy and law. Himachal Pradesh Forest Department. https://hpforest.gov.in/storage/files/4/aboutus/policyandlaw16-07-2020-1594938770.pdf
2. Meghalaya Basin Management Agency. (2025). Guidelines: GREEN Meghalaya. https://www.mbma.org.in/static/ce1841dff279e3170d8ea87c9d6bdcb3/GM+%20GUIDELINES%20%20(1).pdf

BOX 9: Indian examples of blue economy finance

Example 1: Odisha – World Bank Integrated Coastal Zone Management (ICZM)

Focused on mangrove restoration, saline embankments, coastal protection.

Strengthened early warning, community resilience.

Funded by the World Bank under MoEFCC.

Example 2: Gujarat – Blue Carbon & Mangrove Restoration under ICZM-II

Large-scale mangrove plantations financed through international climate and coastal funds.

Created eco-tourism income for coastal villages.

Example 3: Kerala – Sustainable Fisheries & Harbour Modernisation (World Bank)

Harbour upgrades, cold-chain improvements, and community resilience infrastructure.

Delivered through a combination of World Bank loans and State contribution.

Source:

1. World Bank. (2020, April 28). New World Bank program to strengthen integrated coastal zone management in India [Press release]. The World Bank. https://www.worldbank.org/en/news/press-release/2020/04/28/india-integrated-coastal-zone-management

2. Food and Agriculture Organization. (n.d.). India mangrove restoration. FAO. https://www.fao.org/fileadmin/templates/ex_act/pdf/Blue_Carbon_case_studies/India_mangrove_restorat…

3. Press Information Bureau, Government of India. (n.d.). [Blue Economy And Greening Of Fisheries Infrastructure]. Government of India. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2147330&reg=3&lang=2

7. Insurance & risk transfer instruments

Financial tools that help communities and sectors cope with climate-related losses. It is increasingly important due to cyclones, extreme rainfall, landslides, and coastal erosion. District can integrate these through State Insurance schemes and NABARD. It can be built into agriculture, fisheries, and coastal resilience strategies.

Applications for Ratnagiri:

- Crop insurance for climate-affected farmers
- Parametric insurance for cyclone and extreme rainfall impacts
- Heat index insurance for outdoor workers
- Coastal asset risk insurance for ports, aquaculture farms, cold chains

These tools reduce losses, improve recovery, and cushion the financial burden on vulnerable sectors.

Financing type: Premium subsidies, risk pools, state-backed products.

Among these options, CSR, PES, blue economy finance, and MDB-linked state programmes are the most immediately accessible for Ratnagiri, while GCF/AF proposals will require state-level leadership.

5.4 Proposed climate finance mechanism for Ratnagiri

This section outlines *how* Ratnagiri can mobilise, blend, allocate, and track climate finance using the diverse sources identified earlier. It proposes an institutional and procedural mechanism that supports coordinated financing of climate actions across sectors, ensures efficient utilisation of funds, and enables long-term, predictable investment in resilience and low-carbon development.

District Climate Finance Platform (DCFP)

The DCFP is proposed as the district's central coordination mechanism for climate finance, housed under the District Collectorate. Key Functions of the DCFP are:

1. Finance mobilisation & resource convergence

- Pool funds from DPC, state/central schemes, CSR, MDBs, and international climate finance.
- Prioritise and allocate funding based on sectoral climate strategies.
- Blend public and private finance to reduce funding gaps.

2. Carbon finance & aggregation

- Coordinate development of carbon projects across forests, mangroves, agroforestry, soil carbon, and renewable energy.
- Aggregate farmers, JFMCs, SHGs, FPOs, and coastal communities to reduce project costs and streamline MRV.
- Manage benefit-sharing and reinvest carbon revenues into resilience and restoration.

3. Tracking, transparency & reporting (Climate Finance Dashboard)

Maintain a digital dashboard to track:

- Funds allocated and utilised
- Carbon credits generated
- Co-benefits delivered
- Financing gaps and opportunities
- Produce quarterly and annual finance reports aligned with the M&E framework.

4. Coordination & governance

- Ensure cross-department collaboration on climate-relevant activities.
- Serve as the interface between district departments and state/national climate finance bodies.

One platform (DCFP) performs all coordination, carbon aggregation, and reporting functions—ensuring simplicity, clarity, and feasibility.

The DCFP will report to the District Climate Cell (DCC) for all monitoring-related functions. Financial updates—including allocations, utilisation, leverage from external sources, and carbon credit revenues—will be fed into the district's annual and mid-term review cycles outlined in Chapter 3. This integration ensures that climate finance and programme monitoring remain fully synchronised.

Finance mobilisation framework

Step 1: Prepare a 5-year climate budget

- Consolidate funding needs from all sector strategies.
- Identify quick-win, medium-term, and long-term investments.
- Determine financing gaps requiring external or blended support.

Step 2: Match strategies with suitable finance sources

Each strategy is linked to the most suitable finance source—for example, forest landscape restoration can draw on CAMPA, CSR, and carbon credits; mangrove stewardship can tap blue carbon finance, GCF, and MPCB support; EV charging corridors can leverage private-sector PPPs and state EV grants; and solar-hybrid cold chains can utilise MNRE subsidies, CSR, and carbon credits. This mapping enables Ratnagiri to blend multiple finance sources for higher leverage and more effective implementation.

Step 3: Use Carbon Credits as Co-Finance

Within the DCFP, carbon revenues are used not as standalone income but as co-finance to support:

- Nature-based solutions
- Watershed restoration
- Agroforestry expansion
- Mangrove protection
- Climate-resilient rural infrastructure

This creates a predictable funding stream that strengthens long-term resilience programs.

Step 4: Track all finance through the Climate Finance Dashboard

The dashboard—managed by the DCFP—provides real-time visibility into:

- disbursements and utilisation
- carbon credits issued
- sector-wise investments
- generated co-benefits
- funding gaps and required adjustments

This aligns climate finance with the Monitoring & Evaluation system.

Step 5: Annual Climate Finance Review

Led by the District Collector, this review:

- assesses utilisation efficiency
- examines leverage from external sources
- evaluates financing of priority strategies
- supports adaptive management of the finance plan

This ensures accountability and continuous improvement.

The proposed Climate Finance Mechanism centres on a single, integrated platform (DCFP) that mobilises, blends, allocates, and tracks climate finance across sectors. By embedding carbon aggregation and dashboard-based monitoring within the same platform, Ratnagiri adopts a simple, practical, and scalable model to finance its low-carbon and climate-resilient development pathway.

Annexures:

Annexure 1: Taluka-wise LULC changes

Taluka	Class	Area (km²)			% increase
		2017	2024	Difference (2017-2024)	
Rajapur	Water	28.9260	29.2663	0.3403	1.18
	Trees	539.7543	540.4286	0.6743	0.12
	Flooded Vegetation	1.5064	0.9159	-0.5905	-39.20
	Cropland	9.8038	7.4035	-2.4003	-24.48
	Builtup	8.4470	26.7464	18.2994	216.64
	Bare Ground	0.0889	0.0455	-0.0434	-48.81
	Rangeland	621.2752	605.0482	-16.2270	-2.61
Lanja	Water	7.3407	6.6287	-0.7120	-9.70
	Trees	378.0280	355.5252	-22.5027	-5.95
	Flooded Vegetation	0.0002	0.0000	-0.0002	-100.00
	Cropland	9.8013	11.0319	1.2305	12.55
	Builtup	10.6569	27.0063	16.3495	153.42
	Bare Ground	0.0110	0.0000	-0.0110	-100.00
	Rangeland	351.5485	357.2233	5.6748	1.61
Ratnagiri	Water	27.5102	27.2208	-0.2894	-1.05
	Trees	378.7306	356.6454	-22.0852	-5.83
	Flooded Vegetation	2.7153	2.2917	-0.4235	-15.60
	Cropland	13.7825	12.2720	-1.5105	-10.96
	Builtup	42.4965	73.2917	30.7952	72.47
	Bare Ground	0.2697	0.1320	-0.1377	-51.06
	Rangeland	475.2297	468.8194	-6.4103	-1.35
Sanghmehswar	Water	13.9932	14.1361	0.1429	1.02
	Trees	755.8289	737.2183	-18.6106	-2.46
	Cropland	19.2740	14.1289	-5.1452	-26.69
	Builtup	19.9064	53.7446	33.8382	169.99
	Bare Ground	0.0153	0.0005	-0.0148	-96.79
	Rangeland	462.0658	451.9418	-10.1241	-2.19
Guhaghar	Water	24.9665	24.8419	-0.1246	-0.50

	Trees	301.0894	294.3769	-6.7125	-2.23
	Flooded Vegetation	0.0856	0.0230	-0.0625	-73.06
	Cropland	5.2726	4.6055	-0.6671	-12.65
	Builtup	17.7038	32.8513	15.1475	85.56
	Bare Ground	0.2853	0.3668	0.0815	28.57
	Rangeland	294.8878	287.1887	-7.6991	-2.61
Chiplun	Water	14.5329	14.9208	0.3879	2.67
	Trees	577.2667	499.4486	-77.8181	-13.48
	Flooded Vegetation	0.4720	0.4130	-0.0590	-12.50
	Cropland	41.0225	37.7650	-3.2575	-7.94
	Builtup	39.8513	73.9629	34.1115	85.60
	Bare Ground	0.0054	0.0267	0.0213	395.43
	Rangeland	452.8754	499.5638	46.6884	10.31
Mandangad	Water	13.4433	13.6180	0.1747	1.30
	Trees	192.5742	180.5088	-12.0654	-6.27
	Flooded Vegetation	0.2363	0.1180	-0.1183	-50.08
	Cropland	5.6754	4.7908	-0.8846	-15.59
	Builtup	5.6834	12.3784	6.6950	117.80
	Bare Ground	0.0190	0.0001	-0.0189	-99.48
	Rangeland	212.7423	218.9174	6.1751	2.90
Khed	Water	18.5187	17.8980	-0.6207	-3.35
	Trees	481.6423	392.7158	-88.9264	-18.46
	Flooded Vegetation	0.9152	0.8433	-0.0719	-7.86
	Cropland	20.8151	17.4700	-3.3451	-16.07
	Builtup	26.6931	56.2589	29.5658	110.76
	Bare Ground	0.0137	0.0047	-0.0090	-65.65
	Rangeland	488.5218	551.9222	63.4005	12.98
Dapoli	Water	18.6486	18.2805	-0.3680	-1.97
	Trees	414.9508	388.0939	-26.8569	-6.47
	Flooded Vegetation	0.2631	0.1874	-0.0757	-28.78
	Cropland	12.7361	10.0201	-2.7160	-21.33
	Builtup	23.5010	49.3874	25.8864	110.15
	Bare Ground	0.0684	0.0614	-0.0070	-10.28
	Rangeland	403.8113	407.9182	4.1068	1.02

Annexure 2: List of villages that are prone to floods

Taluka	Flood prone villages
Chiplun	Veer, Devpat, Govalkot, Ketki, Gangrai, Karambavane, Waghivare, Bhile, Pedhe Parshuram, Bamnoli, Donavali, Nirbade, Lonari Chivali Bandar, Karjikar Mohalla, Kapare, Pali, Walope, Moravane, Bivali, Dhameli Kond, Maldoli, Kherdi, Hanumangaon, Pedhe, Chiplun, Pilavali Tarf Savarda, Vahal, Khershet, Tondali, Vareli, Asurde, Nandgaon, Nandgaon Kh, Kokare, Kushivade, Nayashi, Yegaon, Gane, Kondhe, Pimpli Kh, Khadpoli, Kaluste, Khandat, Majarekashi, Moravane Bk, Posare, Kalambaste, Waloti, Dalvatne, Gondhale, Uktad, Mirjoli, Bhom
Dapoli	Umbarghar, Bhadavale, Unhavare, Tamond, Damame, Sahilnagar, Usgaon, Pangari Tarf Haveli, Derde, Onanvase, Panderi, Wavghar, Navase, Pharare, Shiravane, Agarvayangani, Degaon, Oni, Katran, Satere Tarf Haveli, Dabhil, Kelil, Pavnal, Bhopan, Gavrai, Urphi, Kalki, Phansu, Karanjali, Panhale Kazi, Kolbandre, Terevayangani, Rukhi, Asond, Pophalwane, Kondhe
Guhagar	Bhatgaon, Dhakka Bhatgaon, Bhatgaon Tisang, Pacheri Sada, Kajurlee, Kolavali, Parchuri, Vadad, Pardalewadi, Talavali, Visapur, Parchuri Kh, Daphalewadi, Pangari Tarf Haveli, Asgoli, Pere, Karul, Patilwadi, Pacheri Agar, Ambere Kh, Bandarwadi, Kudli, Shivane, Guhagar, Katale, Palshet, Nivoshi, Maruti Mandirwadi, Asore, Warweli, Kirtanwadi Tarf Guhagar
Khed	Tale, Nandivali, Apede, Wadi Malde, Mandave, Kalambani Bk, Dhavade, Ghera Rasalgad, Sakharoli Kh, Tise Kh, Nilavane, Wadi Bid, Aini, Tise, Chatao, Valanjawadi, Ambaye, Borghar, Chinchavali, Kandoshi, Vihali, Ghera Sumargad, Kinjale Tarf Khed, Udhale Kh, Udhale Bk, Kalambani Kh, Nandgaon Mohalla, Ashti, Murde, Shiravali, Natu Nagar, Chandewadi, Kajvewadi, Dhamandevi, Chougale Mohalla, Zagdewadi, Panhalaje Kh, Songaon, Panhalaje, Kumbhavali, Matwadi, Gomlewadi, Ambadas, Kadavali, Ghagwadi, Dhamanand, Tumbad, Ghanekhunt, Kotwali, Bhelsai Chauthai, Anaspure, Lote, Bahiravali, Kelane, Dhamanand Gaonthan, Khed, Dhamandevi Mohalla, Mete, Anjani, Avashi, Savanas Kh, Shiv Mohalla, Lavel, Shiv Bk, Karjee Bk, Shiv Kh, Dabhil, Satvingaon, Talaghar, Patilgaon, Koregaon Kh, Jambhurde, Ainavare, Bhoste Mohalla, Hedali, Jambhulgaon, Nilik, Morvande, Kulvandi, Morvande Kh, Mumbake, Nigade, Kondivali Kh, Sanglot Mohalla, Boraj, Mohane, Suseri, Ainavali, Bijghar, Diwalewadi, Kudoshi, Bhoste, Sukivali, Nandgaon, Saveni, Sakharoli, Khalachi, Humbari, Sanaghar, Prabhuwadi, Devghar, Chakale, Kartel, Varovali,

	Sondye, Chinchwadi, Bhadgaon, Bharana Naka, Chinchghar, Bharane, Dhakti Suseri, Devsade, Vetalwadi, Mahalunge
Lanja	Nivoshi, Panore Tarf Harche, Waked, Panore, Roon, Vangule, Vilavade, Golavashi, Beni Bk, Borthade, Harche, Satavali, Lavgan, Isavali, Vervali Kd, Puragaon, Ravari, Khavadi, Panhale, Rambadegaon, Padvan, Bapere, Indavati, Kuve, Wadi Limbu, Khanavali, Bhade, Sadvali
Mandangad	Bhamghar, Borkhat, Sawari, Pacharal, Kalkavane, Dhamani, Veral Tarf Veshwi, Padwe, Dandnagari, Umbershet, Kondgaon, Lokran, Ambavane Bk, Pewe, Panderi, Shigvan, Govele, Kinjalghar, Kumbharli, Panhali Kh, Asawale, Takavali, Bahiravali, Ghumari, Dhangar, Buri, Gothe, Nigadi, Ambadawe, Surle, Adkhal
Rajapur	Vikhare Gothane, Shedhe, Nerakewadi, Chikhalgaon, Solgaon, Gothane Doniwade, Kasheli, Kondsar Kh, Benagiwadi, Rundhe, Varchi Guravwadi, Avali Chiwadi, Kotapur, Ansure, Gunjavane, Wadad Hasol, Wadavali, Palasamkar T Wadi, Watul, Nivkholwadi, Kondsar Bk, Kond Dasur, Devi Hasol, Varachiwadi, Mandrul, Majre Juve, Kelavali, Chuna Kolwan, Taralwadi, Khajantad, Prindrawan, Upale, Bandiwade, Taral, Katali, Jambhari, Palye, Shejavali, Panhale Tarf Saundal, Valye, Mosam, Kondye Tarf Saundal, Thukrulwadi, Khal Chiwadi, Mahalunge, Juvathi, Shengalwadi, Padave, Chauke, Sakhar, Madheliwadi, Karivane, Nanar, Gothivare, Katradevi, Palekarwadi, Rajapur, Hasol Tarf Saundal, Varachiwadi, Pangari Bk, Sogamwadi, Bag Abdul Kadir, Khalchiwadi, Kaneri, Devache Gothane, Keravale, Rautwadi, Shivane Kh, Burbewadi, Goval, Musalmanwadi, Hativale, Dale, Phupere, Barsu, Mandavkarwadi, Angale, Hatankarwadi, Dhopeshwar, Sheel, Kondhe Tarf Rajapur, Shembavane, Doniwade, Panhale Tarf Rajapur, Dasurewadi, Bag Kazi Husen, Sasale, Deulwadi
Ratnagiri	Kasheli, Thombarewadi, Kelye, Ravnangwadi, Nivali, Kasarveli, Sheel, Kotharwadi, Marathewadi, Gaonkhadi, Sadye, Are, Kapilvastu, Pirdavane, Bhave Adom, Basani, Ranpat, Kharavate, Vedarewadi, Kotavade, Lajul, Dhokamale, Vetoshi, Musulmanwadi, Umbarwadi, Kajarekond, Karabudekond, Mulgaon, Dande Adom, Nevare, Ukshi, Khalgaon, Kolisare, Dewood, Agarnaral, Chikhalwadi, Rai, Jambhari, Kharviwada, Miravane, Vaidya Lavagan, Gadnaral, Watad, Dorle, Natunde, Jambhul Aad, Gavade Ambere, Peth Purnagad, Dabhil Ambere, Muslimwadi, Bhandarwadi, Mavlunge, Thikan Chakradev, Shivar Ambere, Kurdhe, Thikanbehere, Mervi, Purnagad, Nakhare,

	Chandor, Nirool, Bondye, Shirgaon, Musalmanwadi, Mhamurwadi, Thikandatye, Sakhar, Majgaon, Mirjole, Padavewadi, Narsinge, Saitavade, Wadajun, Karbude
Sangameshwar	Vayangane, Chandivane, Kante, Ghodavali, Fansat, Pangri, Tulsani, Ambed Bk, Manaskond, Wandri, Kanalkond, Tale, Musalman Wadi, Parchuri, Terye, Mabhale, Kurdhunda, Ozar Khol, Den, Ujgaon, Kolambe, Dhamapur Tarf Devrukh, Shivane, Ambavali, Nawale Wadi, Kirduve, Kondumare, Manjare, Umare, Jambhulwadi, Asurde, Kasba Sangameshwar, Wada Thikanat, Kondye, Dingni Kuran, Davkhol, Bhimnagar, Rampeth, Muchari, Lovale, Wadawesarad, Bhirkond, Nidhalewadi, Navdi, Phungus, Pochari, Kurdhunda Kh, Masarang, Pedhambe, Golavali, Tambedi, Shembavane, Karjuve, Hedali, Kumbharkhani Kh, Antravali, Dhamani, Medhe Tarf Phungus, Dingni, Phansavane, Ambed Kd, Pirandavane, Harekarwadi, Sarand, Asave, Rangav, Makhajan, Narduve, Ambet, Shenavade, Tural, Chikhali, Mavalange, Dhamapur Tarf Sangameshwar, Maladewadi, Shirambe, Burambad, Ambav, Vikas Nagar, Shinde Amberi, Purye Tarf Savarde, Kadvai, Kase, Aravali, Murdav, Kondivare, Kond Ambed, Rajwadi, Upale, Kond Asurde, Sakhalkond, Kalambushi

Annexure 3: List of villages that are prone to landslides

Taluka	Landslide prone villages
Chiplun	Kolkewadi, Pachad, Kondhe, Kaluste, Majarekashi, Chiveli, Devpat, Mirjoli, Ketki, Gangrai, Karambavane, Waghivare, Kutare, Pedhe Parshuram, Donavali, Kapare, Katalwadi, Majare, Asurde, Nirvhal, Talsar, Pophali Bk, Dugave, Pophali
Dapoli	Dabhil, Bhopan, Male, Urphi, Panhale Kazi, Kolbandre, Umbarle, Burondi, Brahmanwadi, Harnai, Dabhol, Umbarghar, Gudaghe, Sondeghar, Pangari Tarf Haveli, Murdi, Onanvase, Tadil, Shiravane, Douli, Vanoshi Tarf Panchanadi, Dumdeo
Guhagar	Asore, Warweli, Dhakka Bhatgaon, Bhatgaon Tisang, Kajurlee, Bandarwadi, Shivane, Guhagar, Aware, Koliwadi Chalkewadi Tr Dhopale, Sakhari Trishul, Dhopare, Navanagar, Parchuri Kh, Abloli, Naravan, Matalwadi, Pere, Are, Karul, Umarath
Khed	Gunade, Jambhurde, Khopi, Bhoste Mohalla, Bajrang Nagar, Shirgaon Kh, Boraj, Ainavali, Shirgaon, Bharane, Ghera Rasalgad, Nilavane, Chougale Mohalla, Zagdewadi, Kumbhavali, Chinchavali, Posare Kh, Tulashi Bk, Kasaba Natu, Bahiravali, Ghogare, Dhamandevi Mohalla
Lanja	Satavali
Mandangad	Bholavali, Kelwat, Ghosale, Veshvi, Valmiki Nagar, Shipole, Bankot, Umroli, Pewe
Rajapur	Pangari Kh, Yeradav, Ajivali, Moor, Chikhalwadi, Chikhale, Karavali, Pajavewadi, Shivane Bk, Kelavali, Hatade, Watul
Ratnagiri	Kajarekond, Karabudekond, Mulgaon, Nevare, Ukshi, Dhamanse, Narsinge, Khalgaon, Ori, Kolisare, Dewood, Agarnaral, Rai, Bhandarwada, Ibrahim Pattan, Kasheli, Madhliwadi, Ravnangwadi, Nivali, Jakimirya, Marathewadi, Mirjole, Narme, Vedarewadi
Sangameshwar	Parchuri, Phansavale, Bamnoli, Kundi, Murshi, Ozare Bk, Manjare, Dingni Kuran, Phungus, Kurdhunda Kh, Pedhambe, Karjuve, Medhe Tarf Phungus, Dingni, Jangalwadi, Meghi, Ninave, Rajivali, Morde, Dakhin, Kondgaon Kh, Kadvai, Kuchambe, Vayangane, Nivali, Parsharamwadi, Pangri, Manaskond, Kosumb, Wandri, Tamhane Kh

Annexure 4: List of villages that are very high, high and moderately vulnerable

Taluka	Village Name	Village Code	Vulnerability status
Chiplun	Kolkewadi	565266	Moderate
Chiplun	Shirgaon	565268	Moderate
Chiplun	Kherdi	565351	Very High
Chiplun	Dahivali Bk	565283	Moderate
Chiplun	Savarde	565326	Moderate
Chiplun	Kokare	565322	Moderate
Dapoli	Palgad	564871	Moderate
Dapoli	Kolbandre	564949	Moderate
Dapoli	Jalgaon	564969	Moderate
Dapoli	Harnai	564829	Moderate
Dapoli	Dabhol	564970	Moderate
Dapoli	Pandhari	564828	High
Guhagar	Sheer	565444	Moderate
Guhagar	Velaneshwar	565432	Moderate
Lanja	Lanja	565995	Very High
Rajapur	Juvathi	566101	Moderate
Rajapur	Karak	566203	Moderate
Rajapur	Talvade	566212	Moderate
Ratnagiri	Watad	565493	High
Ratnagiri	Khalgaon	565543	Moderate
Ratnagiri	Ori	565511	Moderate
Ratnagiri	Nevare	565514	Moderate
Ratnagiri	Kotavade	565521	Moderate
Ratnagiri	Pavas	565649	Moderate
Ratnagiri	Zadgaon	565670	Moderate
Ratnagiri	Kuwarbav	565673	Moderate
Ratnagiri	Nachane	565671	High
Sangameshwar	Dhamapur Tarf Sangameshwar	565689	High
Sangameshwar	Devrukh	565872	Very High
Sangameshwar	Kadvai	565703	Moderate
Sangameshwar	Katavali	565785	Moderate
Sangameshwar	Sadavali	565794	Moderate
Sangameshwar	Kondgaon	565850	Moderate
Sangameshwar	Dabhole Bk	565866	Moderate

Annexure 5: Taluka-wise Forest Carbon Sequestration Potential (Ratnagiri District)

Taluka	% of District Forest Area	Min. Sequestration (t CO_2 yr^{-1})	Max. Sequestration (t CO_2 yr^{-1})	Observations
Khed	38.69 %	160 828	365 527	Dominant forest taluka; large tracts of moist deciduous forest and horticultural plantations; key carbon sink for district.
Lanja	19.02 %	79 063	179 693	Second-largest contributor; moderately dense forest with horticultural tree cover (cashew–mango belt).
Dapoli	14.35 %	59 651	135 573	High canopy density in coastal–hilly transition zones; strong agroforestry mix.
Chiplun	5.56 %	23 112	52 528	Forests fragmented but significant along Ghat slopes and riverine belts.
Ratnagiri	4.98 %	20 701	47 049	Urban expansion zone; residual hill forests and sacred groves.
Guhagar	4.42 %	18 373	41 758	Mangrove–forest mosaic near coastal creeks.
Rajapur	4.48 %	18 623	42 325	Coastal and lowland forests with scrub dominance.
Mandangad	4.51 %	18 747	42 609	Patchy forest cover and plantations; restoration potential high.
Sangameshwar	3.99 %	16 586	37 696	Lower forest area share but high soil carbon due to mixed land use.

References

1. District Planning Office, Ratnagiri. (2023). District Strategic Plan: Ratnagiri 2023–24. Government of Maharashtra.
2. Ibid
3. Office of the Registrar General & Census Commissioner, India. (2011). Ratnagiri District Census Handbook, 2011. Ministry of Home Affairs, Government of India. https://cdn.s3waas.gov.in/s376dc611d6ebaafc66cc0879c71b5db5c/uploads/2018/04/2018041693.pdf
4. Directorate of Economics and Statistics, Government of Maharashtra. (2024). District Domestic Product of Maharashtra 2023–24. Government of Maharashtra. https://cdn.s3waas.gov.in/s376dc611d6ebaafc66cc0879c71b5db5c/uploads/2018/04/2018041693.pdf
5. National Bank for Agriculture and Rural Development. https://www.nabard.org/auth/writereaddata/tender/1012212338Ratnagiri.pdf
6. Sonar, R. B. (2014). Observed trends and variations in rainfall events over Ratnagiri (Maharashtra) during southwest monsoon season. Mausam, 65(2), 171–178. https://doi.org/10.54302/mausam.v65i2.965
7. District Disaster Management Authority, Ratnagiri. (2024). Ratnagiri District Disaster Management Plan 2024. Government of Maharashtra.
8. Yadav, A. B. et al. (2022). Title of the paper. IOP Conference Series: Earth and Environmental Science, 1032(1), 012038. https://doi.org/10.1088/1755-1315/1032/1/012038s
9. Ibid
10. Climate Trace. (2025). Climate Trace website. https://climatetrace.org/
11. District Planning Office, Ratnagiri. (2023). District Strategic Plan: Ratnagiri 2023–24. Government of Maharashtra.
12. Ibid
13. Ibid
14. Climate Trace. (2025). Climate Trace website. https://climatetrace.org/
15. District Planning Office, Ratnagiri. (2023). District Strategic Plan: Ratnagiri 2023–24. Government of Maharashtra.
16. Directorate of Economics and Statistics, Government of Maharashtra. (2023).(District Socio-Economic Review 2023: Ratnagiri District). https://www.mahades.maharashtra.gov.in/files/publication/dsa/2023-24/DSA%202023%20Ratnagiri_011.pdf
17. Directorate of Economics and Statistics, Government of Maharashtra. (2023).(District Socio-Economic Review 2023: Ratnagiri District). https://www.mahades.maharashtra.gov.in/files/publication/dsa/2023-24/DSA%202023%20Ratnagiri_011.pdf

18. TaxTMI. (2025, July 15). Maharashtra signs Rs 31,955 crore MoUs for pumped storage hydroelectric projects generating 6,450 MW power. TaxTMI. https://www.taxtmi.com/news?id=49520&utm_
19. iFOREST analysis
20. District Planning Office, Ratnagiri. (2023). District Strategic Plan: Ratnagiri 2023–24. Government of Maharashtra.
21. Directorate of Economics and Statistics, Government of Maharashtra. (2024). District Domestic Product of Maharashtra 2023–24. Government of Maharashtra. https://www.mahades.maharashtra.gov.in/files/report/DDP%20Final%20Pub_2025_New.pdf
22. Directorate of Economics and Statistics, Government of Maharashtra. (2023). (District Socio-Economic Review 2023: Ratnagiri District). https://www.mahades.maharashtra.gov.in/files/publication/dsa/2023-24/DSA%202023%20Ratnagiri_011.pdf
23. iFOREST analysis
24. Directorate of Economics and Statistics, Government of Maharashtra. (2024). District Domestic Product of Maharashtra 2023–24. Government of Maharashtra. https://www.mahades.maharashtra.gov.in/files/report/DDP%20Final%20Pub_2025_New.pdf
25. Climate Trace. (2025). Climate Trace website. https://climatetrace.org/
26. Directorate of Economics and Statistics, Government of Maharashtra. (2023).(District Socio-Economic Review 2023: Ratnagiri District). https://www.mahades.maharashtra.gov.in/files/publication/dsa/2023-24/DSA%202023%20Ratnagiri_011.pdf
27. Directorate of Economics and Statistics, Government of Maharashtra. (2024). *District Domestic Product of Maharashtra 2023–24*. Government of Maharashtra. https://www.mahades.maharashtra.gov.in/files/report/DDP%20Final%20Pub_2025_New.pdf
28. Climate Trace. (2025). *Climate Trace website*. https://climatetrace.org/
29. District Planning Office, Ratnagiri. (2023). District Strategic Plan: Ratnagiri 2023–24. Government of Maharashtra.

Notes


iFOREST
INTERNATIONAL
FORUM
FOR ENVIRONMENT,
SUSTAINABILITY
& TECHNOLOGY