State Action Plan on Climate Change

for

The State of Goa

for

Period of 2020-2030

Prepared in 2019-2020

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EXECUTIVE SUMMARY

Goa is a coastal state with a significant rise in land elevation from sea to 1022 m. It is one of the smallest states in the country and has a coast length of about 105km. It has very high biodiversity both on land and in the marine system. Tourism is one of the most important sectors of the Goa economy. Other important sectors are mining, fishing, and agriculture.

Climate change scenario

Goa's mean annual temperature has increased by over 1°C since the beginning of the 20th century till date (1901-2018), much of it during 1990-2018 period. The mean annual rainfall in Goa has increased by 68% over the period 1901-2015. With increasing rainfall the inter-annual rainfall variability in the state has also increased especially since 1970s. While mean annual rainfall in the state has increased, moderate to light rainfall days (IMD category I) in Goa have declined over 1901-2015 period, whereas very heavy and exceptionally heavy rainfall events (IMD category III) in the state have increased by a dramatic more than 100%.

Mean annual temperatures (model ensemble) in Goa may increase by around 2°C in 2030s compared to 1901-1950 period, and further to by around 4°C by 2080s under high emission scenarios. Goa will start experiencing heat waves (>40C) beyond the 2040s, as maximum temperature increases by about 5°C towards the century end under high emission scenarios. Minimum temperatures are expected to rise even more by up to 8°C by the century end under the high emission scenarios. The mean annual rainfall in Goa is projected to slightly decline under high emission scenarios, which under low emission scenarios is projected to slightly increase.

The flood vulnerability analysis from the state reveals that 14.73% of the land is under 15meter elevation, much of it in the coastal zones, and are severely vulnerable to flooding both from extreme rainfall events and sea-level rise. In terms of vulnerability from floods and sea-level rise the Taluks Salcete, Tiswadi, and Bardez most vulnerable.

Vulnerability to Climate Change: In the context of Goa, communities living in low lying areas, informal settlements like slum population, people with disabilities and those whose livelihood dependents mainly on khazan lands and low lying ecosystems including riparian ecosystems are in particular the immediate and most vulnerable groups. Also, four coastal taluks of Bardez, Tiswadi, Mormugao, and Salcete, house about 80% of the population and are hubs of economic activity.

It is the moderate and light rainfall events that nourish life-forms and ecosystems, whereas very heavy and exceptionally heavy rainfall events create devastation and chaos to life-forms and ecosystems. Increasing frequency of very heavy and exceptionally heavy rainfall events in Goa is one of the key impacts of climate change witnessed in the state.

Mitigation Strategy

The state of Goa does not produce power, it purchases power from NTPC power plants except for some renewable energy, based power plants like solar power plants. Thus, the direct GHG contribution of the state to national GHG inventory is not significant. Thus, the transportation sector becomes the most important sector in GHG management. Mitigation strategy has been developed for the transportation sector, demand-side energy management, agriculture, and waste sector. Priority sectors include Transport, Energy - Power sector including renewable energy, Water, Agriculture – Forest - Fisheries and allied, Environment and Waste Management Sectors.

Mitigation in the Transportation Sector

The transportation sector is the major source of emissions in Goa and has the maximum possibility for mitigation as well. Due to the large tourist population, which depends on taxis/motorbikes etc for transportation, their lies an opportunity to relook at the transportation sector from a different lens and identify options for mitigation which will also lead to decongestion and reduced pollution.

Some of the mitigation measures proposed are:

1. Development of a holistic policy for low emission sustainable transport system
2. Electric mobility policy should be developed by the state
3. Provisions should be made for non-motorized transportation in urban areas to decongest and reduce GHG emissions
4. The Goa State Subsidy for replacement of old Passenger Buses Scheme, 2001
5. Identify Alternate mode of fuel transportation in the mining area
6. Explore the possibility of using CNG instead of petrol and diesel
7. Solar power vessels for inland waterways
8. Convert existing vessels to CNG vessels (explore possibility)
9. Make adequate parking space for vehicles
10. Provide interconnected public and non-motorized system for point to point connectivity

Mitigation in the Energy Sector

The energy sector in the context of Goa primarily represents the opportunity to reduce demand-side energy consumption and explore new opportunities for renewable energy generation. Some of the mitigation measures which are underway or proposed are as provided below:

1. Power sale agreement has been executed with SECI to meet the additional 50MV wind power
2. Power is also bought from Saligao Solid Waste Treatment Plant for promoting the generation of renewable energy
3. Demand Side Management (DSM) measure, all types of conventional Street light fixtures are being replaced by high-quality efficient smart LED light fixtures under the Street Lighting National Programme (SLNP) of Government of India through Energy Efficiency Services Ltd (EESL), a joint venture of PSUs of Ministry of Power, Government of India on ESCO model.
4. Under the Deendayal Upadhyaya Grameen Jyoti Yojana (DDUGJY) installation of digital meter

5. Jyotirmay scheme - distribution of 3 LED bulbs of 9W each to domestic households. 8.2 lakh bulbs have been distributed under the scheme
6. Goa has executed a Bipartite MoU with the Ministry of Power, Government of India and joined the "UDAY" scheme.
7. Goa Solar policy
8. Goa Wind Policy
9. Goa must explore the possibility of tidal energy and further enhance mini-hydro potential
10. Mandating periodic Energy audit to improve energy consumption and operational efficiency of all government establishments
11. Industrial energy efficiency should be promoted through BEE's programs
12. Incentivization of energy efficiency for commercial and domestic users
13. Programs to develop awareness on saving of energy
14. Training and skill development for renewable energy implementation, maintenance and energy auditors, etc.
15. Present target is 150 MW by 2022 and 300 MW of solar to be set up by 2030
16. 25 MW of renewable energy to be set up by 2030

Mitigation in the Agriculture Sector

Agriculture and allied sectors contribute to GHG emissions due to the use of machinery, water, fertilizers, etc. Inadequate, utilization of resources increases emissions. Methane is one of the main GHG's emitted in agriculture and cattle rearing activities.

Some of the mitigation measures ongoing and proposed are as under:

1. Focus initiatives to increase vermicomposting at the community level
2. Incentivize replacement of agricultural pumps with energy-efficient pumps and solar pumps
3. Sensitize farmers on optimal utilization of water to reduce pump usage and reduce water wastage
4. Incentivize optimal utilization of water pumps
5. Promoting organic manure
6. Optimal utilization of fertilizers and pesticides
7. Assist in utilization of cattle and animal waste as manure and for biogas generation
8. Promoting Biomass residue from agriculture to be used for power generation where it does not have an alternate use

Mitigation in the Environment and Waste Management Sector

Integrated coastal zone management with various interventions including restoration of bunds and sluice gates, initiatives for erosion control measures – coasts and rivers, Biodiversity conservation initiatives, Wetland conservation and restoration, bold initiatives such as ban on single use plastic, mechanism for effective system for extended manufacturers responsibility in waste sector are some of the measures in environment sector.

The first major initiative is the collection of all the plastic waste across the National Highways and the second major initiative is setting up of Solid Waste Treatment Facility one each, in North Goa and South Goa.

Few important items in Goa's waste management strategy should include:

1. Waste minimization in the tourism sector by providing alternate and bio-degradable options for tourist
2. Incentivising disposal of plastic waste by providing ride coupons or other tourist coupons in exchange for disposal or deposition of plastic waste at designated areas

Sectoral Adaptation Strategy

Water Sector

Though Goa is situated in high precipitation zones, it has one of the lowest per capita freshwater availability. The draft state water policy 2015 presents various challenges faced by the state in the utilization of the water resources. The rivers are prone to tidal variations up to 40 km inland and seasonal variation in the availability of water. Given these the key adaptation strategies for water sectors are:

1. Adaptation of water-related infrastructure
2. Development of infrastructure to reduce the impact on water availability and enhance water security
3. Developing systems for appropriate planning of water to ensure water supply to all
4. Maintenance of water resources to avoid flooding and to keep related infrastructure functional during peak events and disasters
5. Knowledge management and capacity building (Forecasting and database building)
6. Awareness Raising

Tourism Sector

Tourism is one of the most important economic sectors of the state. It receives tourists, three to four times the total population of the state.

Adaptation strategies proposed for the tourism sector are:

1. Promoting community-based agritourism
2. Inland tourism development in a climate-friendly manner
3. Tourism infrastructure climate vulnerability assessment
4. Climate proofing and disaster management for critical tourism infrastructure
5. Develop design standards for new tourist infrastructure and guide modification of existing vulnerable infrastructure
6. Enhance/modify and restructure the insurance for off-coast or water-related tourism activities and infrastructure like boats and ships which are vulnerable to climate change
7. Incentivize the use of eco-friendly, recycle/reuse in the tourism sector by facility providers
8. Single-use plastic to be banned with credible alternates in tourism activity
9. Provide extensive infrastructure and encourage the use of non-motorized transport by tourist - Develop a climate-friendly tourist mobility plan
10. Green Skill and capacity development amongst the tourist service providers
11. Environmental Clearance for large tourism projects/hotels in Goa could include climate mitigation and adaptation plan and climate disaster preparedness plan
12. RE-consider the coastal development plan or zone for new construction based on the climate predictions on sea-level rise, flooding, and erosion
13. Reducing hotspot vulnerability

Mining Sector

Mining in Goa is primarily focused on the sand and iron ore. Sand mining is directly influenced by the growth of the construction sector, does increase the sensitivity of the coastal system to coastal hazards.

Adaptation strategies for mining sector:

1. A comprehensive study of Hydro Geology of underground water to be carried out
2. Independent mining audits to ensure compliance with EIA/clearances and other parameters
3. Explore and provide treated water for mines or alternate sources
4. Resource efficiency and circular economy concept need to be incorporated into the construction sector to reduce pressure on the sand as a resource.

Agriculture and allied sector

Goa has only one agro-climatic zone i.e. West Coast Plains & Ghat Region and the state primarily depends on rain-fed agriculture. The agriculture sector is facing challenges like the decline in interest towards agriculture, Erosion of soil and deterioration of soil quality, very high labour wages, EROSION OF LOCAL GERMPLASM and introduction of GMO seeds and khazan lands.

Adaptation strategies for agriculture sector are:

- Maximizing the agricultural land utilization by including fallow land for agriculture
- Climate Research in Agriculture by the development of regional knowledge, development of climate risk indicators, acceptable coping ranges of the sector and specific crops, which are critical to improving climate risk management
- Increase overall investments in agricultural research and development.
- Technological innovation, research in agriculture will be promoted.
- Increasing farmer income through credible, certified organic farming and market connections
- Encourage education in agriculture and educate farmers
- Fisheries management to include integrating fisheries and aquaculture management into coastal zone management, to increase the coping ability of small communities to sea-level rise. Breeding fishes which can withstand higher temperatures.
- Livestock management by breeding temperature tolerant species, and providing temperature resistant livestock shelter.

The ICAR Goa would be the primary research organization which will work in conjunction with and State agriculture department. Similarly, Fisheries board, animal husbandry, and associated bodies would work together on the other aspects.

Forest and biodiversity

Goa is the smallest state with just 3702 sq. km. of geographical area is having a good forest cover with 1,225.12 sq. km of recorded Government Forest which is over 33% of the total geographical area of the State. Out of this 62% is designated as 7 Protected Areas, 6 biodiversity-rich and ecologically sensitive Western Ghats and one in Mangrove forest at Chorao island.

There is no further potential to increase the forest cover of the state, however, there is a possibility to increase the green cover and increase the quality of the forest by increasing the carbon content.

States first biodiversity heritage site has been registered at Purvatali Rai located in Bicholim Taluka, Dedicated project on biodiversity and livelihood is initiated for 7 years duration, integrated approach for dealing with climate change for developing climate resilient models and various other initiatives are taken through biodiversity management committees constituted at local body level. Participatory process of chronicling of biodiversity and associated traditional knowledge is the scientific process adopted to understand inventory of biodiversity, ground level situation, issues associated, priority conservation focus areas with respect to biodiversity are part of initiatives of Goa State Biodiversity Board. Revival of traditional systems including proposed seed bank are initiatives proposed.

Identification and notification of wetlands in the State of Goa by Goa State Wetland Authority is a significant step towards water security, biodiversity conservation, climate resiliency and also responsible sustainable initiative.

The strategies for Goa are:

1. Enhance the forest quality
2. Restore and increase the coastal defence mechanism
3. Prepare a strategy to prevent and control forest fires
4. Afforestation and Plantation outside the forest
5. Support private forest owners in the sustainable management of their forests and derive economic benefit
6. Water and Soil conservation
7. Capacity building of field staff
8. Promote Ecotourism

Human Health

Goa has 13 government hospitals with 3000 beds and 29 community/primary health centres and 30 dispensaries. It has about 2756 beds in private hospitals [1]. The changing climate has increased the occurrence of diseases like dengue and introduced new diseases like Kyasanur Forest Disease (KFD).

Adaptation strategies:

1. Prepare an action plan to reduce the climate change related health impacts
2. Develop an IT enabled system to inform the public on possible and actual disease outbreak
3. Study and map new and emerging diseases in the state concerning climate change
4. Prepare a heatwave action plan
5. Develop a system to predict disease outbreak
6. Assess the adequacy and resilience of health infrastructure to climate change
7. Strengthen the health infrastructure based on the assessment
8. Enhancing the knowledge skills of health workers

Habitat

62% of Goa's population lives in cities. About 80% of the state population lives in four coastal talukas of Bardez, Tiswadi, Mormugao, and Salcete. To be able to effectively meet the requirements of the growing population and economic activity in these talukas it is essential to not only prepare effective land use plan but also to provide and maintain:

- Water and Sanitation Services
- Transportation services

- Solid waste management
- Energy demand
- Health services and health management

Adaptation strategy is as below:

1. Climate based infrastructure vulnerability assessment of critical services
2. Development of a plan for the resilience of vulnerable structure associated with critical services
3. Redesigning the regional land use planning maps of most vulnerable areas after considering climatic factors
4. Identifying measures like creating flood control gates etc. for controlling flooding events due to various aspects like the upward flow of water into the rivers
5. Development of climate-based disaster management plan
6. Implementation of the solid waste management plan
7. Enhancing internal waterways for transportation
8. Strategy to relocated/compensate and identify new means or alternate skill for the owners of khazan lands as the probability of submergence due to climate change increases
9. Identify and explore natural mechanisms like increased mangroves or sea walls etc. to guard against sea level rises.

Financial and Institutional Arrangement for Implementing the Mitigation and Adaptation strategies

The total budget required for implementing the SAPCC in Goa has been projected to be INR ₹ Rs 465.00 Crores for ten years, which works out to be ₹ 46.5 Per Annum and amounts to approximately 0.22% of Annual Budget and 0.050 % of Gross State Domestic Production (GSDP) of Goa State. The same may get revised or updated over the years, based on any additions or modifications to the SAPCC. One of the steps for mainstreaming climate change is to factor the above-identified amount annually into the state budget. A state nodal agency on climate change will be formed for the which will serve as the climate change secretariat for the State of Goa. The nodal agency shall be allocated budget or financial assistance from the state for carrying out its activities. Each of the concerned departments will appoint a nodal officer on climate change to interact and deal with the climate change secretariat.

People's participation is an essential part of the SAPCC. SAPCC provides a plan for including people from all sections of the society. The M&E framework consists of:

1. Qualitative and quantitative indicators of adaptation
2. Indicators are attempted to be as ambiguous as possible
3. Monitoring, reporting and communication process for departments and the policymakers

[1] Goa at a glance 2017-18

1. Introduction

1.1. Background

Climate change and its impacts are no longer a subject of the future. Its impacts are being evidenced globally. Extreme events causing severe impact have been evidenced in the last decade at several places. The UN High Commission on Refugees (UNHCR) has estimated that since 2009, one person every second has been displaced by a disaster as a result of climate change.

Climate change threat varies from country to country and region to region in large countries like India. India has a very diverse climate from continental to coastal, from extremes of heat to extremes of cold, from extreme aridity and negligible rainfall to excessive humidity and torrential rainfall. Nearly two-thirds of the countries annual precipitation is received through the southwest monsoon in the months of June to September in most parts of the country. Many parts of India are vulnerable to floods during the monsoons which cause significant loss of life and damage to livelihood systems, property, infrastructure, and public utilities. As per the second BUR of India, flood risk has increased significantly over India during the recent decades. India's exposure to natural hazards can be gauged from the fact that it experienced 431 major natural disasters during the period 1980-2010. The flood events of recent years in the states of Uttarakhand, Jammu & Kashmir and Kerala are examples of such disasters.

To respond to the threat of climate change in a systematic manner the government of India announced the National Action Plan on Climate Change (NAPCC) in the year 2008. NAPCC has eight missions –

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission for Sustainable Habitats
- National Water Mission
- National Mission for Sustaining the Himalayan Eco System.
- National Mission for Green India
- National Mission for Sustainable Agriculture
- National Mission for Strategic Knowledge for Climate Change

Due to large diversity in the country and the existing political and administrative structure, it is essential for the States and Union Territories, as well to understand, identify and develop state-specific responses to climate change. Hence, MoEFCC has encouraged states and UTs to develop their state action plan on climate change (SAPCC) consistent with the NAPCC.

India is a signatory to the Kyoto Protocol and is committed to the Paris Agreement on climate change. Under the Paris Agreement India has officially submitted its nationally determined contribution (NDCs) on 2nd October 2015.

As per the Paris Agreement, all signatories will attempt to limit global mean temperature within 2degree Celsius and work towards to limit 1.5degree Celsius. India has submitted its Nationally Determined Contributions (NDC) goals for post-2020 with eight different goals including three major quantifiable goals related to emission reduction, renewable energy, and forestry. The following targets form the core of India's NDC:

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate-friendly and cleaner path than the one followed hitherto by others at a corresponding level of economic development.
3. To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level. 4. To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 with the help of the transfer of technology and low-cost international finance including from Green Climate Fund (GCF).
4. To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030.
5. To better adapt to climate change by enhancing investments in development programs in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health, and disaster management.
6. To mobilize domestic and new and additional funds from developed countries to implement the above mitigation and adaptation actions given the resource required and the resource gap.
7. To build capacities, create a domestic framework and international architecture for quick diffusion of cutting-edge climate technology in India and joint collaborative R&D for such future technologies.

To meet the NDC's in addition to the adaptation measures, SAPCCs need to be revised and strengthened further considering the evolving context of climate science, policies, and actions.

1.2. Need for State-level action

Goa is a coastal state with a significant rise in land elevation from sea to 1022 m. It is one of the smallest states in the country and has a coast length of about 104km. It has very high biodiversity both on land and in the marine system. Tourism is one of the most important sectors of the Goa economy. Other important sectors are mining and industries, fishing, and agriculture. All the key economic sectors in Goa's economy have the potential to get significantly impacted by climate change.

The second national inventory under the BUR report for 2014 has been submitted by India. According to the report, India emitted 2607.49 million tonnes CO2e (excluding LULUCF) and 2306.3 million tonnes CO2e (including LULUCF) in 2014. Out of the total emissions, the energy sector accounted for 73%, IPPU 8%, agriculture 16% and waste sector 3%. Land Use, Land Use Change, and Forestry sector offset about 12% of India's total emissions. GOI has taken various direct and indirect measures to reduce its emissions.

The direct contribution to India's GHG emissions is low as the state does not generate electricity and is relatively small in size and population. However, the state does have the potential to implement demand-side management measures in electricity and contribute to countries' overall effort to meet the NDC.

Goa is exposed to several climate risks like loss of land due to erosion, loss of life, livelihood, the outbreak of disease, damage to buildings, drainage, and other infrastructure. It is also exposed to sea-level rise, storms, high-speed wind, altered runoff, changed wave pattern and sea temperature in addition to the other threats like rainfall and temperature profile changes. The characteristic of states other natural and geographical features like rivers, khazan lands, soil type, and moisture and flora and fauna will result in unique or varied results in different climate scenarios.

The Canacona flash flood is one such event experienced by the state of Goa on 2nd of October, 2009. It was found that these flash floods were directly related to about 271 mm of rain that fell in a short span of 7 hours, resulting in flooding of Talpona and Galjibag Rivers. Due to continuous rainfall in the monsoon season, the soil on slopes was saturated. As a result, on steep slopes with altitude above 300 m, the cascading water led to mudslides. At altitudes of about 50 m or more, agricultural and horticultural areas were submerged and cattle were washed away. At lower altitudes (about 50 m or less), where the topography is flatter, accumulation of water submerged buildings, and as the water made its way towards the sea, the flow destroyed houses and commercial establishments, particularly those that were weak (mud houses, for example). There are no records to suggest the precedence of such a rainfall scenario in the past.

It is interesting to note that the flooding on 2 October 2009 was unprecedented in recorded history, but the total daily precipitation on that day is not. Hence, it implies that similar rainfall can have different risk profiles depending upon the month in which it occurs.

Thus, the state-specific action plan on climate change is necessary to understand and pave the way forward on climate change in the state of Goa. The present plan envisages wide coverage including priority sectors and his based on inclusive approach of planning based on extensive process of consultations.

2. Goa State Profile

2.1. Location, geography and size

The State of Goa, located between 140 53' 57''N and 150 47' 59'' N Latitudes and 730 40' 54''and 74053'11'' E Longitudes. It covers an area of 3702 sq. km. and accounts for about one percent of the total geographical area of the country. Goa was elevated to the status of the 25th State of India Union on 30th May 1987. The boundaries of the State are well defined in the north by Terekhol River which separates it from the state of Maharashtra. Western Ghats are protecting the State in the east and is bordered with the state of Karnataka and in the west, it is surrounded by the Arabian Sea.

The State consists of 2 administrative districts i.e. North Goa and South Goa, which are further divided into 12 talukas viz. Pedne, Bardez, Bicholim, Sattari, Tiswadi, Ponda, Mormugaon, Salcette, Sanguem, Dharbandoda, Quepem, and Canacona.

After attaining statehood the number of towns in the state increased from 15 to 70 and the number of villages has decreased from 407 to 334[1]. The state has 14 municipalities, 320 inhabited villages. The above is indicative of increasing urbanization in Goa and decreasing rural population. Generally speaking, the rural areas of Goa exhibit semi-urban characteristic.

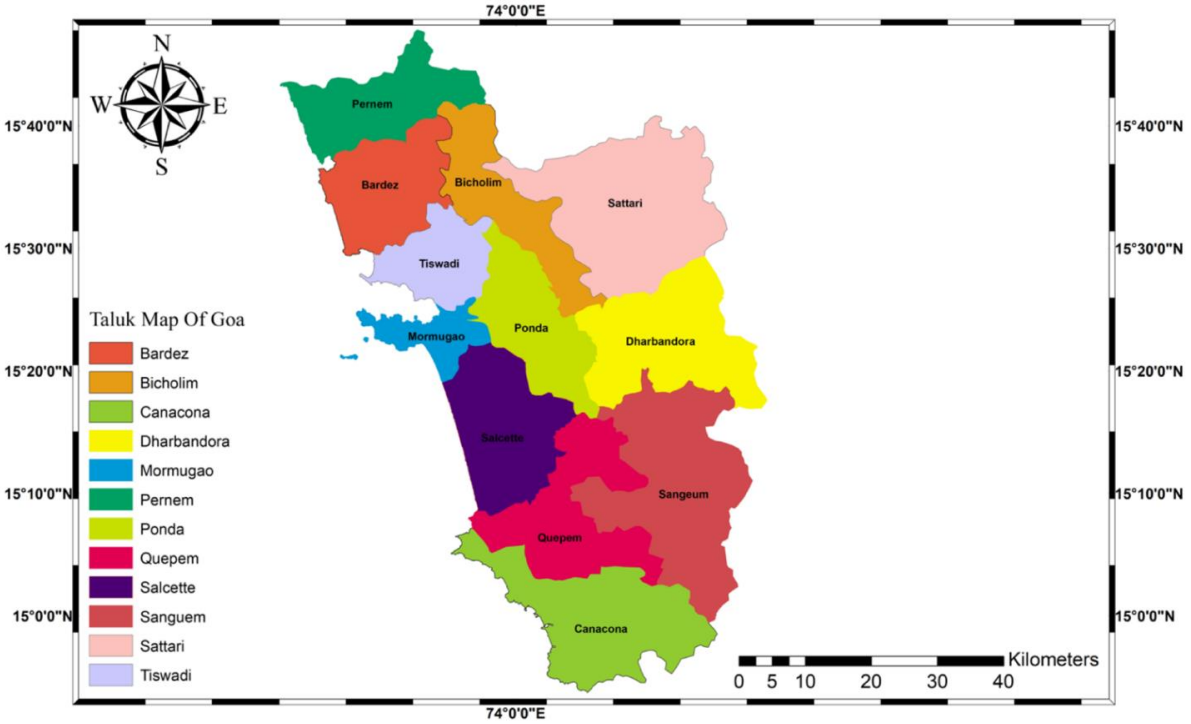


Figure 1: Map of Goa

2.2. Socio-Demographic profile

The State of Goa supports a human population of 14.59 Lakhs (Census 2011) which is about 0.12% of India's population. The average population density has increased in the last 20 years from 272 persons per sq. km to 394 persons per sq. km. The population density of Goa is higher than the national population density of 382 persons per sq. km. While the population density of Goa has increased the decennial population growth rate has reduced significantly from 26% in 1987-88 to 8.23% as per the Census 2011. The decadal growth rate of the population of the State for the decade 1991-2001 was 15.21%. Thus, indicating the overall population pressure will decrease further in the coming decades.

Table 1: Year wise Population and Decadal Growth 1900-2011

Year	Total Population	Decadal variation	Decadal growth (%)
1900	4,75,513	-9289	-1.9
1910	4,86,752	11,239	2.36
1921	4,96,494	-17,258	-3.55
1931	5,05,281	35,787	7.62
1940	5,40,925	35,644	7.05
1950	5,47,448	6,523	4.21
1960	5,89,997	42,549	7.77
1971	7,95,120	2,05,123	34.77
1981	10,07,749	2,12,629	26.74
1991	11,69,793	1,62,044	16.08
2001	13,47,668	1,77,875	15.21
2011	14,58,545	1,10,877	8.23

More than 62% of the population reside in urban areas and about 38% in rural areas. The sex ratio stands at 973 females per thousand males as against the National sex ratio of 943. As per the 2011 Census, 11,65,487 persons in the State are reported to be literate which constitutes 88.70 % of the total population. The State's workforce is about 577548, which constitutes 39.58% of the total population in the State.

Table 2: Demographic Profile of the State[1]

Item	Value	Unit
Total population	14.59	lakhs
Male	7.39	lakhs
Female	7.2	lakhs
Sex ratio (females per "000" males)	973	
Population Density	394	person per sq.km
Average household size	4.24	persons per household
Decennial growth of population	8.23	%
Urban Population	9.07	lakhs
Rural Population	5.52	lakhs
Overall Literacy Rate	88.7	%

[1] All information is as per the Census of 2011

Overall urban Literacy	89.95	%
Overall Rural Literacy	86.65	%
Urban Women	85.56	%
Rural Women	81.63	%

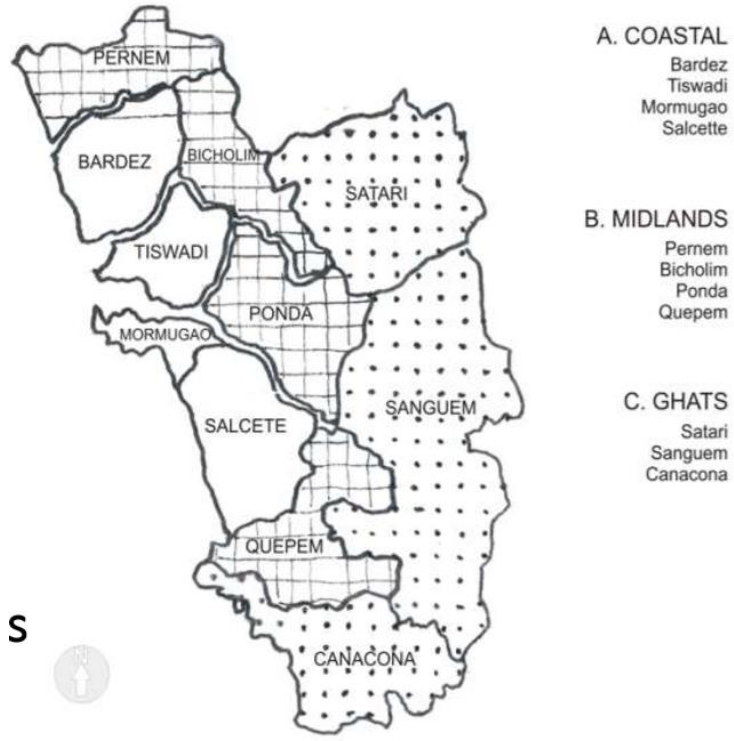
2.3. Geophysical profile

The State of Goa has a hilly terrain especially on its eastern side, where lies the southern end of the Sahyadri ranges. These mountains, after skirting a considerable portion of the north-eastern and south-eastern boundaries, branch off westward across the State with many spurs and ridges. The terrain is interspersed by several rivers flowing westwards, which provide a network of internal waterways. The important rivers are Mandovi (Originates and is known as Mhadeyi in most areas along the course), Zuari, Terekhol, Chapora, Sal, Betul, Talpona, Galjibag, Cumbarjua, Valvanti, Mapusa, Sinquerim, Khandepar and Kushavati. The rivers are navigable for a total length of 256 Kms. The coast is full of creeks and estuaries formed by these rivers which provide a good shelter for fishing crafts. The 105 km long coastal line of Goa is endowed with some of the loveliest beaches in the world which have earned the frame of bearing idyllic beauty spots.

The land elevation ranges from sea level to 1022 meters. The highest point is the Wagheri hills in Sattari taluka. The natural vegetation of Goa consists of dense forest and dry deciduous to moist deciduous type. Moderately sloping lands with laterite outcrops are covered by grass and shrubs. The habitat of the flora is of semi-evergreen type. Evergreen forests are seen only on high hills. The vegetation consists of trees, shrubs, herbs climbers, sedges and grasses. The coastal tracts are namely covered by palms and mangroves. Goa receives rains from the southwest monsoons. The average annual rainfall of the State, as recorded is 2776.9 mm. The rainy season is spread over four months from June to September. Occasional thundershowers are experienced in May and October. Goa experiences a warm and humid tropical climate. The summer temperature ranges from 24°C to 36°C. In winter, the mercury hovers between 21°C to 30°C. Due to the Global Warming effect, the picture seems to be slightly changing.

Goa receives rains from the South West monsoons. The average annual rainfall of the State, as recorded is 2776.9 mm. Rainy season is spread over four months from June to September. Occasional thunder showers are experienced in May and October. Goa experiences warm and humid tropical climate. The summer temperature ranges from 24°C to 36°C. In winter, the mercury hovers between 21°C to 30°C. Due to Global Warming effect, the picture seems to be slightly changing.

Figure 2:Geographical Zones of Goa



2.4. Economic Development of the State

The GSDP at constant (2011-12) prices for the year 2016-17 is estimated at more than INR 51,692 crore as against INR 44717 crore in the year 2015-16 (Provisional Estimates) thereby reflecting a growth of 15.60% as against 11.47% in 2015-16[3]. About 40% of the total population in Goa forms its workforce [4]. Per capita income increased from INR 3,19,827 in 2014-15 to INR 4,25,749 in 2016-17. Goa has one of the highest per capita Net state domestic product (NSDP) in the country.

The population of the State primarily depends on agriculture for livelihood. As per the economic survey 2017-18, the growth rate over the previous year under Primary Sector was negative during the period 2013-14 with -43.83 percent due to impact on the mining sector. Thereafter, in 2014-15 to 2015-16, the growth rate under the primary sector improved at 0.03 percent and 15.88 respectively. This was mainly due to the resumption in mining and quarrying activity wherein the growth rate improved from -5.35 percent in 2014-15 to 1130.60 percent in 201516. The growth rate under Secondary sector registered negative growth during the year 2013-14 reflecting -20.10 percent and thereafter improved to 56.65 percent during 2014-15 and 13.77 percent during 2015-16. The positive growth in the secondary sector continued during 2016-17 and stood at 18.36 percent. Similarly, the growth rate under the Tertiary Sector which was 3.24 percent in 2013-14, went up to 9.63 percent in 2014-15 and 7.34 percent in 2015-16. This was mainly because of the improvement in transport and financial services.

Table 3: Sector wise Percentage composition of GSDP at Current Prices (Percent)

Sector	2012-13	2013-14	2014-15	2015-16(P)	2016-17(Q)
Primary	12.54	9.86	7.29	8.20	9.26
Secondary	49.06	44.06	53.79	53.97	55.18

Tertiary	35.40	46.08	38.92	37.83	35.56
Total	100.00	100.00	100.00	100.00	100.00

2.5. Sectoral profile of State[2]

Primary Sector

Goa's primary sector mainly comprises of agriculture, forestry and fishing and mining and quarrying. For NSDP (at current price), under the sub-sector of the primary sector, Forestry and Logging has recorded the highest growth rate of 29.23 percent, followed by, Fishing and Aquaculture, Livestock and Crops with growth rates of 26.74%, 19.88%, and 13.75% respectively. The sub-sector of Mining and Quarrying have also recorded positive growth rates of 204.09% in 2016-17 as against the growth rate of 715.43% in 2015-16(P).

Secondary Sector

The sub-sectors of the Secondary sector, "Electricity, Gas & Water Supply & other Utility Services" recorded a growth of 31.47 percent followed by the sub-sector manufacturing with 23.13 percent and construction with 11.18 percent.

Tertiary Sector

Under the sub-sectors of the tertiary sector, Transport by means other than Railways recorded the highest growth of 33.44 percent followed by the sub-sectors Transport, Storage, Communication and Services related to Broadcasting (26.87 percent), Other services (16.92 percent) & Public Administration (12.50 percent).

2.6. State specific development issues

Khazan land: Some of the coastal land in Goa has been reclaimed from the inundation of the tidal waters by constructing embankments. These lands are known as Khazan lands and cover an area of about 18,500 hectares. These lands in Goa are made of saline alluvial soils. They are used for the cultivation of paddy and form an important part of Goa's agricultural profile. Khazan lands are vulnerable as any sea-level rise or intrusion of salinity upstream can harm the quality of groundwater and soil quality. During 2017-18, up to 31/12/2017 under the State Sector, about 750 ha of Khazan paddy land have been protected and about 1.94 km of long bunds are repaired. The state has incurred an expenditure of INR 75.64 lakh on account of this work.

Drifting Occupations: Tourism has become a major industry in Goa and attracts domestic and foreign tourists from all over the globe. It, directly and indirectly, employs about one-third of the state's population. Due to alternate. As Goa has a high literacy rate and alternate options of income are available, the state is witnessing a drift from agriculture. Eventually, leading to agriculture being a secondary source of income, instead of the primary source. It poses a unique challenge for the state where due to economic prosperity the inherent knowledge on agriculture and agrobiodiversity of the state is likely to be lost.

[2] Economic Survey of Goa 17-18

Potential Threat to Biodiversity and Agriculture due to changing trends: Genetically modified organisms and crops (GMOC) are also a cause of concern for the State as the impact of the introduction and mainstreaming of these are yet to completely understood. Most of the agriculture and allied activities in the State are at subsistence level and completely synchronized with the natural system. The introduction of GMOC may threaten the age-old system and might shift the balance from self-sustaining to industry dependant, intensive input-based agriculture.

Power Dependency: Goa does not produce any power and is dependent on NTPC plants in other states for supply of power whereas demand for power due to increased urbanization, industrialization, a boom in construction activity, commercialization, consumerism is constantly increasing. It is a serious issue that plagues the State of Goa.

Illegal and Non-compliance in Mining Sector: In all, 38 Mining Leases are in operation during the current year (till December 2017) which have reported production of Iron ore to the tune of 6.08 million Tons. Due to rampant illegal mining, several sectors in the State like water, biodiversity, and environment were getting impacted. Rash and careless driving in and around the mining area increases accidents. To curb the impacts a ban was imposed on mining activities during the year 2013-14, which has been lifted in subsequent years with the more stringent implementation of laws. However, the problem continues to concern the development of the state.

- Effective implementation of CRZ rules for new development in areas sensitive to subsidence. Effective ICZMP plan and its execution by GCZMA and Dept. of Environment.

- Bund restoration, khazan land rejuvenation, riverine ecosystem restoration etc.

3. Process of Development of SAPCC

3.1. Guiding Principle in development of SAPCC

Common guidelines and principles have been developed by the Ministry of Environment, Forest and Climate Change (MoEFCC) to be followed by all States and Union Territories in India. This SAPCCC of the State of Goa is also based on these fundamental guidelines and principles of MoEFCC as mentioned below:

a) SAPCCs should be a policy document of the States/UTs outlining the major initiatives and strategies reflecting the commitments and proposed actions in the state to tackle the vulnerabilities and impacts of climate change across the socio-economic sectors. It should reflect the policy directions and strategies of the state for climate actions.
b) It should envisage inclusive, sustainable and climate-resilient low carbon development pathways, with a focus on climate change adaptation and mitigation within the key sectors in the States/UTs and should protect the poor and vulnerable sections of society from adverse effects of climate change.
c) It should take into account recent scientific assessments and projections on global warming; vulnerability; and impacts. Climate models and high-resolution downscaled projections must be considered while assessing the vulnerability and preparing sectoral adaptation plans.
d) It should synergize with the goals of NDCs under the Paris Agreement, though the targets under NDCs are national targets. It should also contribute towards achieving other development goals including Sustainable Development Goals (SDGs). SAPCC should also complement prevalent national development and policy initiatives inter alia National Forest Policy, Biodiversity Goals, National E-Mobility Programme, Swatch Bharat Mission to reap greater developmental co-benefits.
e) It should highlight the links with national missions related to climate change. It should bring out climate actions of the state government from their own sources, over and above the Government of India schemes.
f) The SAPCC should also be built on the evolving socio-economic development context and priorities of the state.
g) SAPCCs should integrate and mainstream climate change concerns in the different sectors and policies/programs of the States in alignment and consistent with the existing schemes and programs within the states/UTs.
h) It can strengthen existing climate action measures as well as launch new initiatives in their priority sectors.
i) The period of the implementation of SAPCCs should start with the implementation cycle of NDCs i.e. 2021-2030 and beyond.
j) Financial resources required for the implementation of the action plan primarily to be leveraged from the existing budget of the State Governments and convergence with the relevant schemes and programs. The SAPCC should also bring out the likely funding from State's own resources over and above from the ongoing schemes and programs of Govt. of India.

k) It should set out the institutional mechanism for implementation including stakeholder engagement ensuring inclusiveness along with the mechanism for capacity building and monitoring and evaluation with clear indicators for reporting.

3.2. Process of development

SAPCC has been developed in line with MoEFCC guidelines through a structured multi-stakeholder consultative approach. The state of Goa has formed a State Level Steering Committee group, which is responsible for the development of SAPCC. Identification of key departments, research organization and other stakeholders especially from the State of Goa and to engage and receive their feedback and inputs for the SAPCC is the responsibility of the State Level Steering Committee group.

Figure 3: Key Activities in development of SAPCC as defined by MoEFCC

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The State Governing Council

The State Governing Council shall be the decision-making authority in terms of the implementation of SAPCC.

Sr. No.		Designation
1.	Hon. Chief Minister	Chairperson
2.	Hon. Minister for Environment and Climate Change	Vice-Chairperson
3.	Chief Secretary	Member (*Ex-Officio)*
4.	Secretary, Department of Environment	Member (*Ex-Officio)*
5.	Secretary, Department of Science and Technology	Member (*Ex-Officio)*
6.	Secretary, Goa Energy Development Agency	Member (*Ex-Officio)*
7.	Secretary, Department of Power	Member (*Ex-Officio)*
8.	Secretary, Water Resource Department	Member (*Ex-Officio)*
9.	Secretary, Department of Agriculture	Member (*Ex-Officio)*
10.	Secretary, Department of Transport	Member (*Ex-Officio)*
11.	Secretary, Department of Forest	Member (*Ex-Officio)*
12.	Secretary, Department of Health	Member (*Ex-Officio)*
13.	Member Secretary, Goa State Biodiversity Board	Nodal Officer for Secretariat

Simultaneously, the Steering Committee for the SAPCC has also been formulated at the State level to ensure appropriateness and coherence of the SAPCC with the state's vision and guidance. The State Steering Committee for SAPCC is headed by Chief Secretary.

Table 4: State Steering Committee for SAPCC

State Steering Committee Members	**Department/Organization/ Designation**
Chief Secretary	Chairperson *(Ex-Officio)*
Secretary (Environment)	Member *(Ex-Officio)*
Chief Secretary (Forest)	Member *(Ex-Officio)*
Secretary (Agriculture)	Member *(Ex-Officio)*
Secretary (Health)	Member *(Ex-Officio)*
Secretary (Renewable Energy Source)	Member *(Ex-Officio)*
Chief Secretary (Transport)	Member *(Ex-Officio)*
Secretary (Disaster Management)	Member *(Ex-Officio)*
Under Secretary (Finance)	Member *(Ex-Officio)*
Director, Department of Agriculture	Member *(Ex-Officio)*
Director, Department of Fisheries	Member *(Ex-Officio)*
Director, Department of Animal Husbandry and Veterinary Services	Member *(Ex-Officio)*
Director, Directorate of Health	Member *(Ex-Officio)*
Director, Directorate of Transport	Member *(Ex-Officio)*

Director, Department of Science and Technology	Member *(Ex-Officio)*
Chief Engineer, Water Resources Department	Member *(Ex-Officio)*
Principal Chief Conservator of Forests, Forest Department	Member *(Ex-Officio)*
Member Secretary, Goa State Pollution Control Board	Member *(Ex-Officio)*
Member Secretary, Disaster Management Cell	Member *(Ex-Officio)*
Member Secretary, Goa Energy Development Agency	Member *(Ex-Officio)*
Dean, Marine Science Department, Goa University	Member *(Ex-Officio)*
General Manager, NABARD or his/ her nominee	Member *(Ex-Officio)*
The Member Secretary, Goa State Biodiversity Board	Nodal Officer
Director, Department of Environment	Convenor *(Ex-Officio)*

To develop the SAPCC following activities were carried out:

a) Extensive stakeholder consultation
b) Data collection from departments
c) Secondary data collection through desk review and research
d) Climatic modelling for future projections
e) Data analysis using appropriate tools for vulnerability assessment

3.3. Stakeholder Consultation Process

Climate change in an interdepartmental topic and requires understanding, coordination, and implementation by various departments and stakeholders in the state. Two key types of consultations were conducted for the development of SAPCC:

1. Individual-level consultation with concerned departments, institutes, and organizations
2. Group stakeholder consultations at various locations with stakeholders from all sections of the society i.e. institutes, NGOs, local community representatives, etc.

Stakeholder feedback through structured feedback form during the consultation.

Additionally, an email ID was created to receive feedback from stakeholders over 10 days during the consultation period.

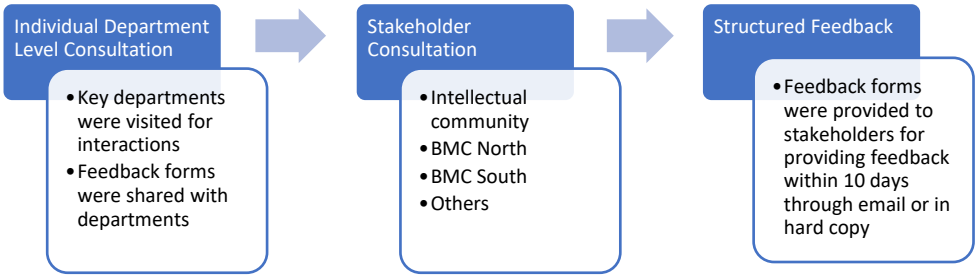

Figure 4: Stakeholder consultation process adopted

The **objective** of departmental stakeholder consultations was to understand from the departments their activities, policies, budget, resources, and plans for the state. These consultations also provided an understanding of the gaps in understanding climate change, actions that were aligned to climate change and the constraints that could be faced due to climate change and in the implementation of climate adaptation and mitigation strategies and interventions for the state.

Stakeholders consulted during the stakeholder consultation process and the public stakeholder consultation are provided below:

Table 5: Stakeholder Consultation for Development of SAPCC

Stakeholder consultation date and venue	**Stakeholder types consulted**
21/03/2017; Crown Hotel, Panaji	Members of State Level Steering Committee
28/11/2017; Hotel Orion, Panaji	Members of State Level Steering Committee and core committee members
05/11/2019; Goa International Centre, Dona Paula	Biodiversity Management Committees of North Goa
06/11/2019; Goa International Centre, Dona Paula	Biodiversity Management Committees of South Goa
07/11/2019; Goa International Centre, Dona Paula	Experts from various fields Scientists from NIO, officers from various departments, researchers from Goa University, etc
Questionnaire for climate change was circulated and inputs were compiled accordingly	General Public
Finalized SAPCC to be further presented for approvals and necessary modifications	

3.4. Key stakeholder feedback

Feedback received through group-level stakeholder consultations has been summarized below to reflect the stakeholder understanding of climate change, impacts experienced and their views on the response measures needed for climate proofing the State of Goa.

a) Awareness on Climate Change

Overall understanding and awareness on climate change issues were high amongst the stakeholder groups. Stakeholders have described it as a very important topic for mankind. According to the stakeholders, climate change affects every human being along with the flora and fauna on a very. The impact of climate change is significant and will continue to increase. They have emphasized the need to start preparing and planning on tackling the issue immediately to avoid a major disaster. They have emphasized on the need to develop strategies and implement at the local level to conserve the existing biodiversity. Information on weather-related warnings is received through the internet and news. Stakeholders described temperature rise, variation in rainfall, the intrusion of the sea as some of the observed climate change phenomena in Goa.

b) Impacts of Climate change experienced by stakeholders

i. Changes in ecosystem observed due to pollution and climate change

a. Some of the examples of these changes expressed by stakeholders are the disappearance of some of the bird species like sparrow and parrot, quality of fish harvested from the capture fisheries, invasive fish species leading to biodiversity erosion, decrease in shellfish at the coast and decrease in insects.

ii. Changes due to change in rainfall patterns and other non-climatic stressors

a. Some of the changes cited by stakeholders are drying up of water bodies (like wells and lakes) during summer leading to agricultural loss, over usage of groundwater to serve commercial utilities.

iii. Altered monsoon pattern or sequence has been observed

iv. Health issues due to change in the ecosystem and climate change

a. There has been an increase in vector-borne diseases and various allergies like cold, bronchitis, asthma, bird flu, swine flu, etc. An example expressed during stakeholder consultation was a reduction in the breeding of frogs, which has led to an increase in mosquitoes. This further increases diseases like Malaria, Filaria, Dengue and many more.

v. Changes due to temperature and other stressors

a. Some of the examples are eutrophication of water bodies, occurrences of harmful algal species from some of the estuarine systems of Goa suggesting water quality deterioration, unusual shortage of water or good quality of water over the years

vi. Impact of Land use change

vii. Land-use change has been expressed as a concern that leads to the destruction of forest and mangroves on a large scale and it also impacts agricultural land

viii. Rainfall quantum and intensity has changed

a) A daily commuter is impacted by flooding causing inconvenience in daily activity, overflow of sewers due to the high intensity of rains. Infrastructure most impacted due to weather events are road infrastructure, public health, power availability, food type and quality, internet and telephone connectivity. A specific example of waterlogging of roads near the creek area of Jorda, cultivated fields were cited.

Sea level rise and associated problems of bund breaching and need for restoration of khazan lands

It was expressed that sea level rise has been experienced in some areas which has led to soil erosion, impacted access to sea beaches, disappearance of sea shells and fishes. Flooding of Khazan lands was specifically expressed as a concern while water level in creeks like those at Tarda was also reported to have increased.

Specific observation and concern

The **TENANTS ASSOCIATION OF CAMARCASANACHO BUNDH** ward no. 8 of Camarkazana, Acoi, Bilou and Peddem has a huge stretch of river which connects to the Arabian sea through the river Mandovi. This ward lies at the lowest point in the whole of the Mapusa City/Aldona Constituency and therefore finds itself to be vulnerable and susceptible to the ongoing climate change and the increase of the sea level.

b) Response for Climate Proofing Goa

Community involvement: Generally, the stakeholders have expressed a need to involve every citizen in the implementation of climate change response by increasing the awareness level of citizens on climate change. While the stakeholders also expressed the need for government to take overall responsibility on developing and executing strategies to combat climate change, considering the local experiences and practices.

A strong need was expressed to create awareness amongst the citizens on the impacts and actions needed from every individual by introducing the topic in school and college syllabus.

It was also emphasized that creation of a Task Force for Climate Change to monitor the effects of climate change involving the local communities should be considered by the government. Such communities can assist to oversee that the laws/activities identified for combating climate change are enforced in the State of Goa. It would help the Government of Goa and People of the State to be better prepared. Citizen mascots can also create awareness amongst communities on climate change action. Youth mascots were also recommended.

One of the measures suggested was regular meeting by concerned departments with the people affected due to climate change and to involve citizens in climate change activity to increase citizen sensitivity and generate positive attitude towards biodiversity and climate friendly practices

c) Other proposals

i. Reduction of pollution and decreasing deforestation and increasing the forest cover through afforestation, improving mangrove management, protection of trees through base mapping
ii. The *Manos* or the embankments along the Border of our Rivers require immediate repaired, and strengthening to withstand the rising Sea levels.
iii. Timely dredging of rivers to be undertaken
iv. To reduce pollution and GHG emissions garbage burning should be stopped, buses older than 15 years should be banned, availing public transport should be encouraged
v. Barriers to avoid water logging of agriculture fields
vi. Revival of community resource systems, enhancing resource management and reducing consumption was also emphasised
vii. Do not link rivers to de-risk
viii. Enhancing in ground water protection
ix. Imposition of heavy fines on violators
x. Illegal mining to be stopped and development activities in eco-sensitive zones as well should be stopped including cutting of hills and land filling with debris
xi. Planting more trees
xii. Protection of water resources through harvesting water, preventing excessive supply of water through tankers
xiii. Using products that generate less heat
xiv. Local bodies to have plan of action – develop models which will enable hands-on learning in our State itself was expressed.

4. Climate Change in Goa: Observations and Projections

Due to the build-up of greenhouse gases (GHGs) in the atmosphere, global temperatures are rising. The atmospheric CO2 concentration has increased from 285 ppm during pre-industrial times (mid 1700s) to ~410 ppm in 2019. In response to this GHG build-up, the global mean temperatures have already risen by about 1°C compared to pre-industrial times (Met Office, 2015). Indian sub-continent is also experiencing rapid warming particularly since 1980s. As per IMD (2019) analysis, the annual mean temperature during 1901-2018 period showed an increasing trend of 0.6°C/100 years. As per IMD (2019) assessment significant increasing trend was seen in maximum temperature (1.0°C/100 years), and relatively lower increasing trend (0.2°C/100 years) in the minimum temperature over India.

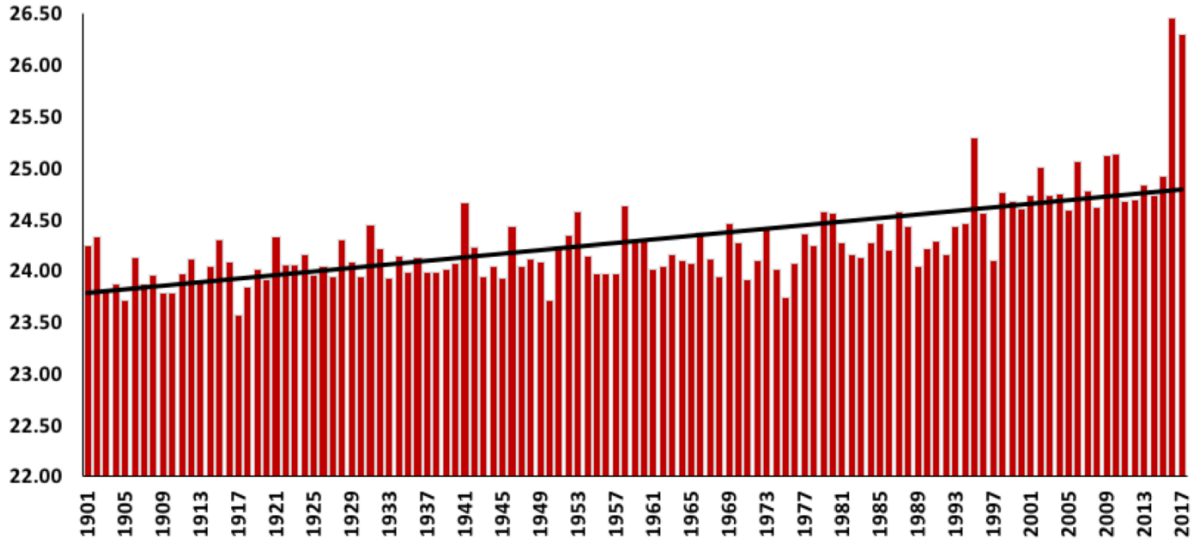

Figure 5: ***Observed temperature change (in Deg C) in India (Source: IMD, 2019)***

As GHG build-up is project to further rise in the 21st century, future temperatures are expected to rise even further. It is agreed by the scientific community that global temperatures should be capped below 1.5 – 2°C, which creates the dangerous threshold for climate change. The Paris Agreement aims to limit warming below these levels. At all India level Chaturvedi et al 2012 project that "under the *business as usual* (between RCP6 and RCP8.5) scenario, mean warming in India is likely to be in the range of 1.7 to 2°C by 2030s and 3.3 to 4.8°C by 2080s relative to pre-industrial times", further it was project that "all India precipitation under the *business as usual* scenario is projected to increase from 4% to 5% by 2030s and from 6% to 14% towards the end of the century (2080s) compared to the 1961-1990 baseline".

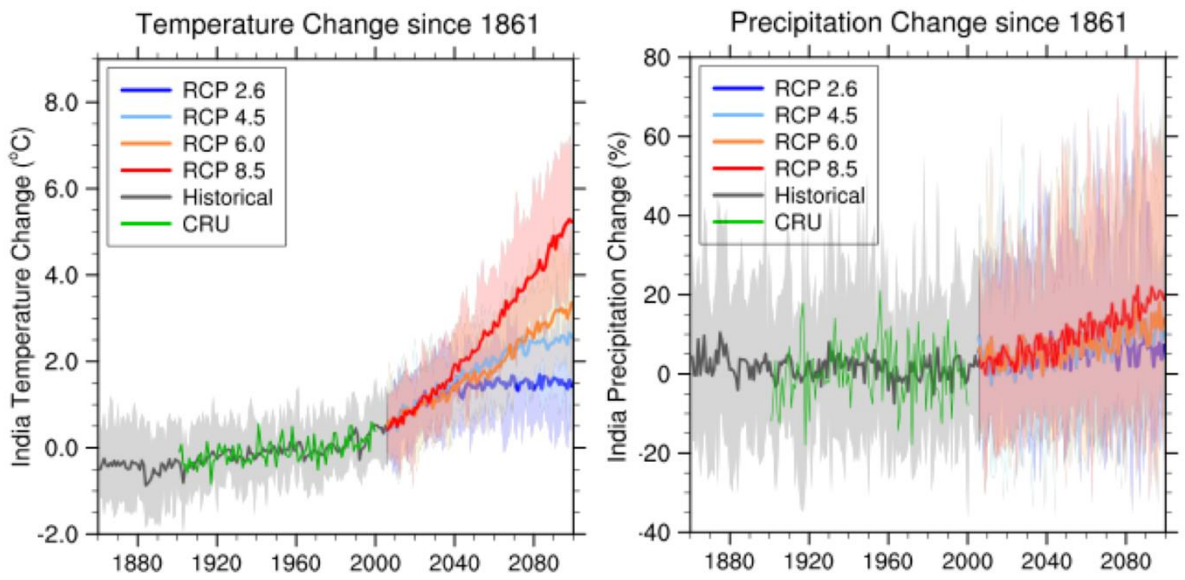

Figure 6: National level projections for temperature and rainfall in the 21st century (based on Chaturvedi et al 2012)

The global CMIP5 model ensemble-based annual temperature change (°C) projected for 2030s, 2060s and 2080s relative to the pre-industrial baseline (1880s) for the four RCP scenarios. All-India annual mean temperature increases by 1.7–2.02°C by 2030s under different RCP scenarios and by about 2–4.8°C by 2080s, relative to the pre-industrial base. The above figure projects a consistent warming trend over the country in short-, mid- as well as long-term scenarios. As expected in each of the three time slices RCP2.6 generally experiences the least warming, whereas RCP8.5 is associated with the highest warming, with RCP4.5 and RCP6.0 representing the moderate warming scenarios. Generally, the northern part of the country is projected to experience higher warming compared to the southern counterpart.

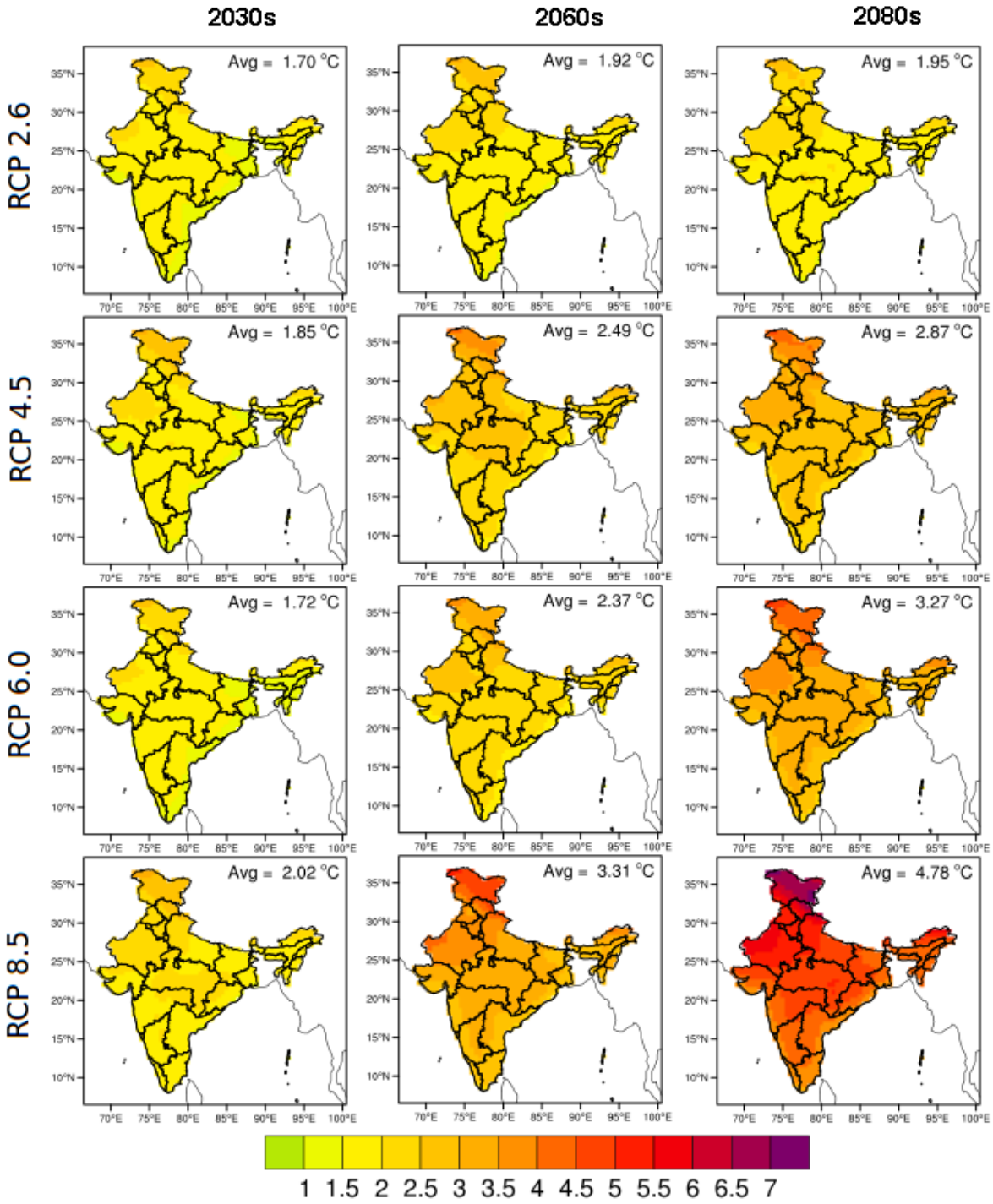

Figure 7: CMIP5 model ensemble mean temperature change (°C) projected for 2030s (2021-2050), 2060s (2046-2075) and 2080s (2070-2099) relative to the pre-industrial period (1880s i.e over 1861-1900)

Figure 7 shows the CMIP5 model ensemble-based annual precipitation change (%) projected by 2030s, 2060s and 2080s respectively, compared to the pre-industrial base- line (1880s) for the four RCP scenarios. All-India annual precipitation increases by 1.2–2.4% by 2030s under different RCP scenarios and by 3.5–11.3% by 2080s, relative to the pre-industrial base. Precipitation is projected to increase almost all over India except for a few regions in short-term projections (2030s). As noted in the temperature trends in each of the three time slices, RCP2.6 experiences the least increase in precipitation, whereas RCP8.5 experiences the highest precipitation increase, and the precipitation changes are larger for each subsequent period (i.e.

short, mid and long term)

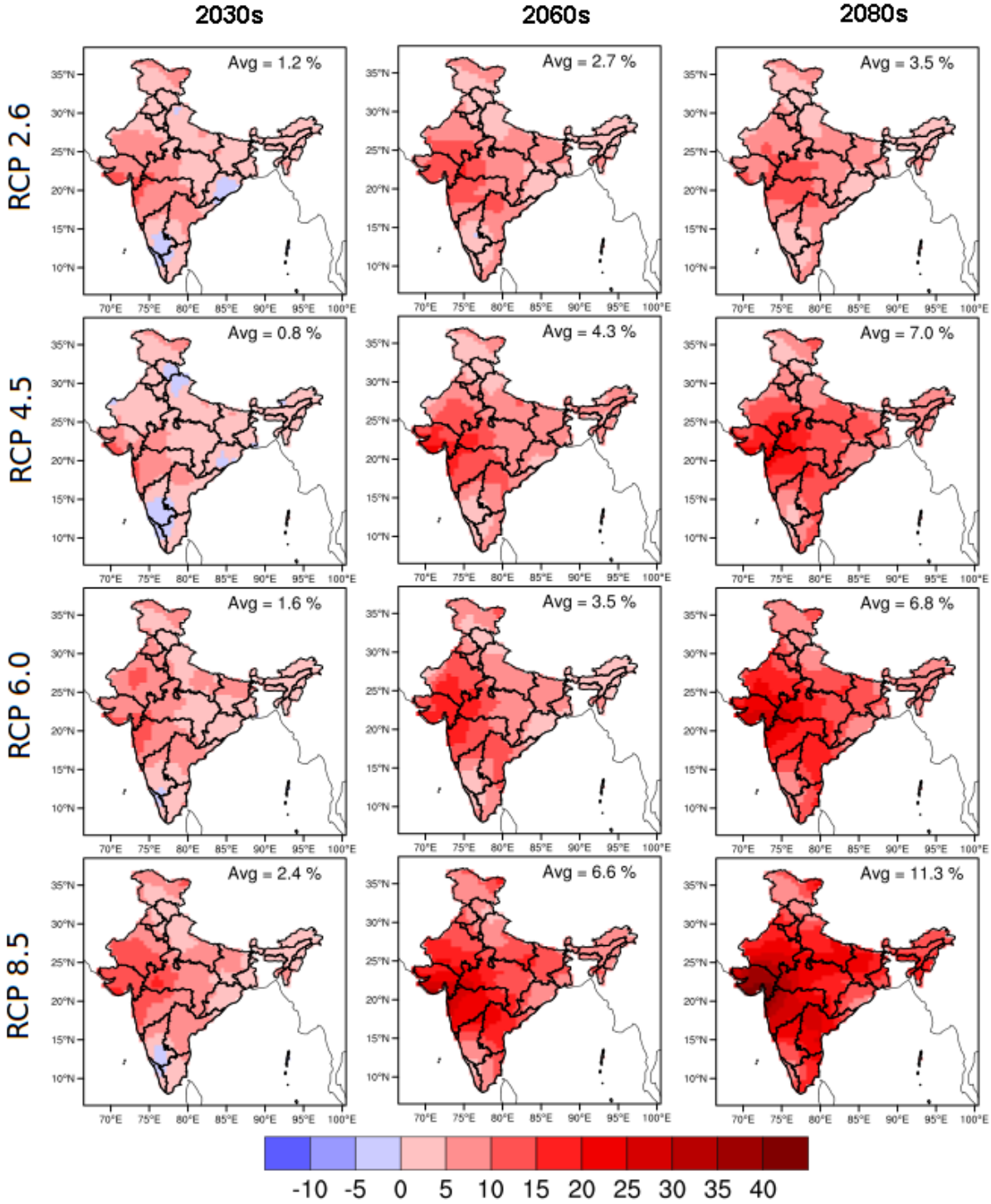

Figure 8: CMIP5 model ensemble mean precipitation change (%) projected for 2030s (2021-2050), 2060s (2046-2075) and 2080s (2070-2099) relative to the pre-industrial period (1880s i.e over 1861-1900) (Source: Chaturvedi et al 2012)

For Goa state climate change projections are not available. Thus, climate projects and past climate analysis has been carried out for the SAPCC. Following is achieved by this analysis and presented in this chapter:

1. Updated long-term climate profile for the Goa state based on the 1951-2014 period as per revised IMD methodology
2. It investigates as to what extent changes in mean and extreme climate occurred in the State of Goa during the period of 1901-2015
3. Investigates climate projections in Goa in the 21st century based on high resolution regional climate models.
4. Assesses the relative vulnerability of different parts of Goa to inundation and floods

Methodology

For the purpose of all analysis carried out in this chapter, including the analysis of climate profile, observed climate change trends as well as climate change projections, are carried out using this map.

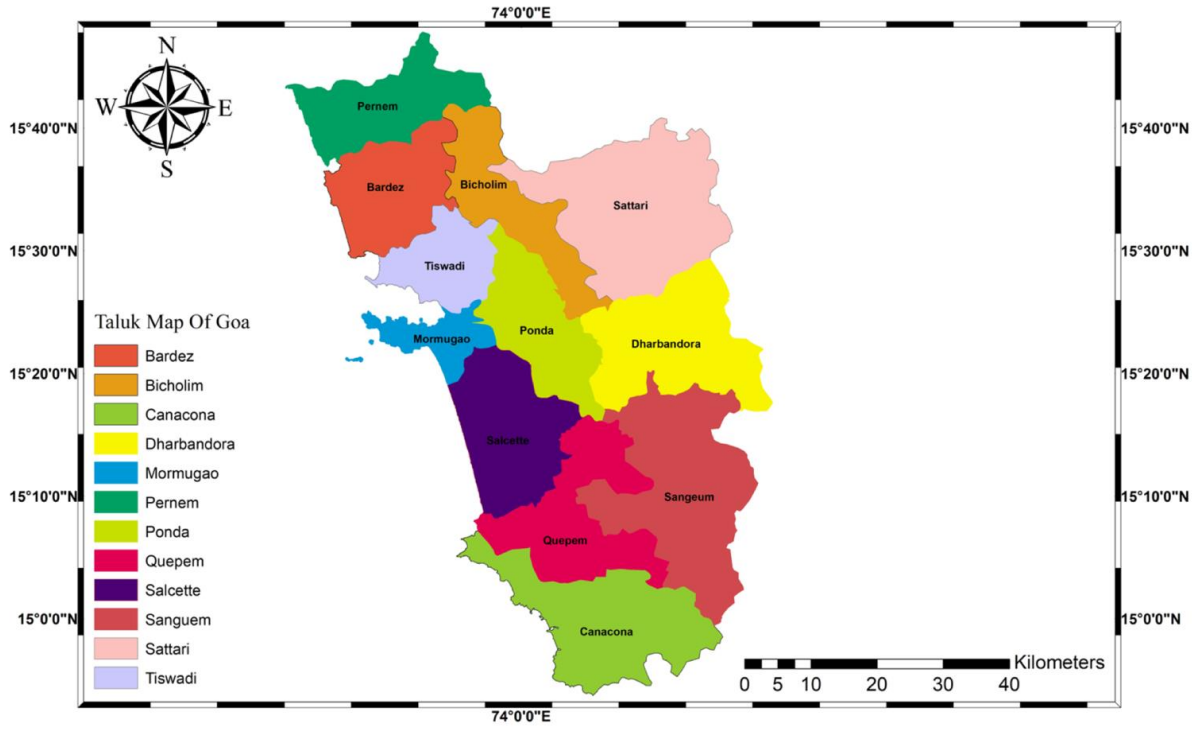

Figure 9: Taluk Map of Goa for climate modelling

Observed gridded climatology data for temperature and rainfall is obtained from India Meteorological Department, Government of India (Pai et al 2014) and the Climate Research Unit (CRU) of East Anglia, UK (Harris et al 2014). IMD provides gridded temperature data at a resolution of 1°X1°, which roughly translates into 100 Km in length and 100 Km in width, meaning a single pixel in the IMD covers an area of about 10,000 Sq. Km. Goa state on the other hand is 105 Km in Length and 65 Km in width, and has an area of 3,702 Km^2, which means any given IMD pixel will atleast have 63% of its area outside the Goa state and most probably much of it may lie in the neighbouring ocean which will have a sharp temperature gradient. Hence, it is decided that the coarse IMD observed temperature dataset may not be appropriate for assessing the observed climate change in Goa's landmass. This analysis uses, observed temperature dataset as provided by the Climate Research Unit (CRU) of East Anglia,

UK (Harris et al 2014) for the analysis of temperature profile in the state as well as assessing the changes in temperature in the state over the period 1901-2018. CRU dataset (Harris et al 2014) is available at a spatial resolution of 0.5°X0.5°, and for a time period of 1901-2018. Gridded rainfall data from IMD is available at a much finer spatial resolution i.e. 0.25°X0.25° (Pai et al 2014). This high resolution observed rainfall dataset (1901-2015) is used for the analysis of rainfall profile of the state as well as for assessing the changes in observed rainfall in the state over the period 1901-2015.

In order to project climate in the 21st century, the scientific community has developed a set of new emission scenarios termed as Representative Concentration Pathways (RCPs) (*http://www.iiasa.ac.at/web-apps/tnt/RcpDb/dsd?Action=htmlpage&page=welcome*). There are four RCP scenarios: RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5 – these scenarios are formulated such that they represent the full range of stabilization, mitigation and baseline emission scenarios available in the literature. The naming convention reflects socio-economic pathways that reach a specific radiative forcing by the year 2100. For example, RCP 8.5 leads to a radiative forcing of 8.5 Wm^{-2} by 2100. While four RCP scenarios are available, we have used the RCP scenarios of RCP4.5 and RCP8.5. These are briefly described in table below.

Table 6: Description of RCP scenarios

RCPs	**Description**	**Developed by**
RCP 4.5	It is a stabilization scenario where total radiative forcing is stabilized before 2100 by employing a range of technologies and strategies for reducing greenhouse gas emissions.	MiniCAM modeling team at the Pacific Northwest National Laboratory's Joint Global Change Research Institute (JGCRI) (Wise et al., 2009)
RCP 8.5	The RCP 8.5 is characterized by increasing greenhouse gas emissions over time representative for scenarios in the literature leading to high greenhouse gas concentration levels.	MESSAGE modeling team and the IIASA Integrated Assessment Framework at the International Institute for Applied Systems Analysis (IIASA), Austria; (Riahi et al., 2007)

Climate projections for the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) are made using these newly developed representative concentration pathways (RCPs) under the Coupled Model Inter-comparison Project 5 (CMIP5). More than 50 CMIP5 model outputs are now available from different climate modelling groups. Since CMIP5 models outputs are available at coarse resolution, in order to facilitate local and regional adaptation planning Co-Ordinate Regional Downscaling Experiment (CORDEX) was carried out. In India Indian Institute of Tropical Meteorology, Pune hosted these experiments and have since provided multiple dynamically downscaled high resolution climate model projections for the South Asian domain, including India. It is desirable that CORDEX South Asia model

projections are used for State Action Plan on Climate Change (SAPCC). The cordex south asia models presented in the table below have been downloaded and evaluated for these projections.

Table 7: Evaluated CORDEX South Asia models for this report

Model Name	**CORDEX SA RCM**	**Contributing CMIP5 Modeling Center**	**Model Resolution (in Km)**
ACCESS1-0	CCAM	CSIRO, Australia	50*50 Km
CCSM4	CCAM	National Center for Atmospheric Research (NCAR), USA	50*50 Km
CNRM-CM5	CCAM	Centre National de Recherches Me´te´orologiques (CNRM), France	50*50 Km
MPI-ESM-LR	REMO2009	MPI-M, Germany	50*50 Km
GFDL-CM3	CCAM	National Oceanic and Atmospheric Administration (NOAA)	50*50 Km
MPI-ESM-LR	CCAM	Max Planck Institute for Meteorology (MPI-M), Germany	50*50 Km
NorESM1-M	CCAM	Norwegian Climate Centre (NCC), Norway	50*50 Km
LMDZ4(IPSL)	RegCM4-11	CCCR, IITM, India (Not a CMIP5 contribution	35*35 Km
EC-EARTH	RCA4	Irish Centre for High-End Computing (ICHEC), European Consortium (EC)	50*50 Km

However, since the regional climate projections data from most of the models is incomplete/ truncated, the following CORDEX south asia models for which full time-series till 2100 is

available for at least the two climate scenarios of RCP 4.5 and RCP8.5: Access 1.0, CCSM4 and MPI-ESM-LR.

Spatial Downscaling: Goa is a small state, hence even the dynamically downscaled climate projections at 0.5X0.5 resolution are not adequate for the analysis of the spatial variability in climate. Hence, spatial downscaling techniques are employed to improve the climate projection datasets. Temperature component of the climate model projections which are available at a spatial resolution of 50*50 Km, is downscaled to very high resolution using the elevation adjusted bias correction method (Gerlitz et al 2014). Whereas, rainfall projections (available at 50*50 Km resolution) are downscaled using the high resolution gridded observed rainfall datasets as provided by IMD to 0.25°*0.25° resolution. Downscaling method as well as results of this analysis are described in *Vignesh et al (in preparation)*.

In order to analyse the flood and inundation risk and vulnerability in Goa under current climate as well as under future climate, high-resolution digital representation of orography based on SRTM Digital Elevation Model (DEM), published by the CGIAR-Consortium for Spatial Information (http:// srtm.csi.cgiar.org), with a cell size (spatial resolution) of 90 m, is used (Farr et al.2007, Reuter et al. 2007).

Temperature Profile in Goa:

Below shows the mean annual temperature map of Goa over the long-term period of 1951-2014. Methodology and data source for this figure is described in Venkateswaran and Chaturvedi (in Preparation). Mean temperature in Goa is found to be 26.70C, which is higher than the national average annual temperature is about 23.3C (Chaturvedi et al 2012). While spatial temperature variability is not high in goa, hilly areas in the eastern parts of the state are generally cooler than the coastal areas in the west.

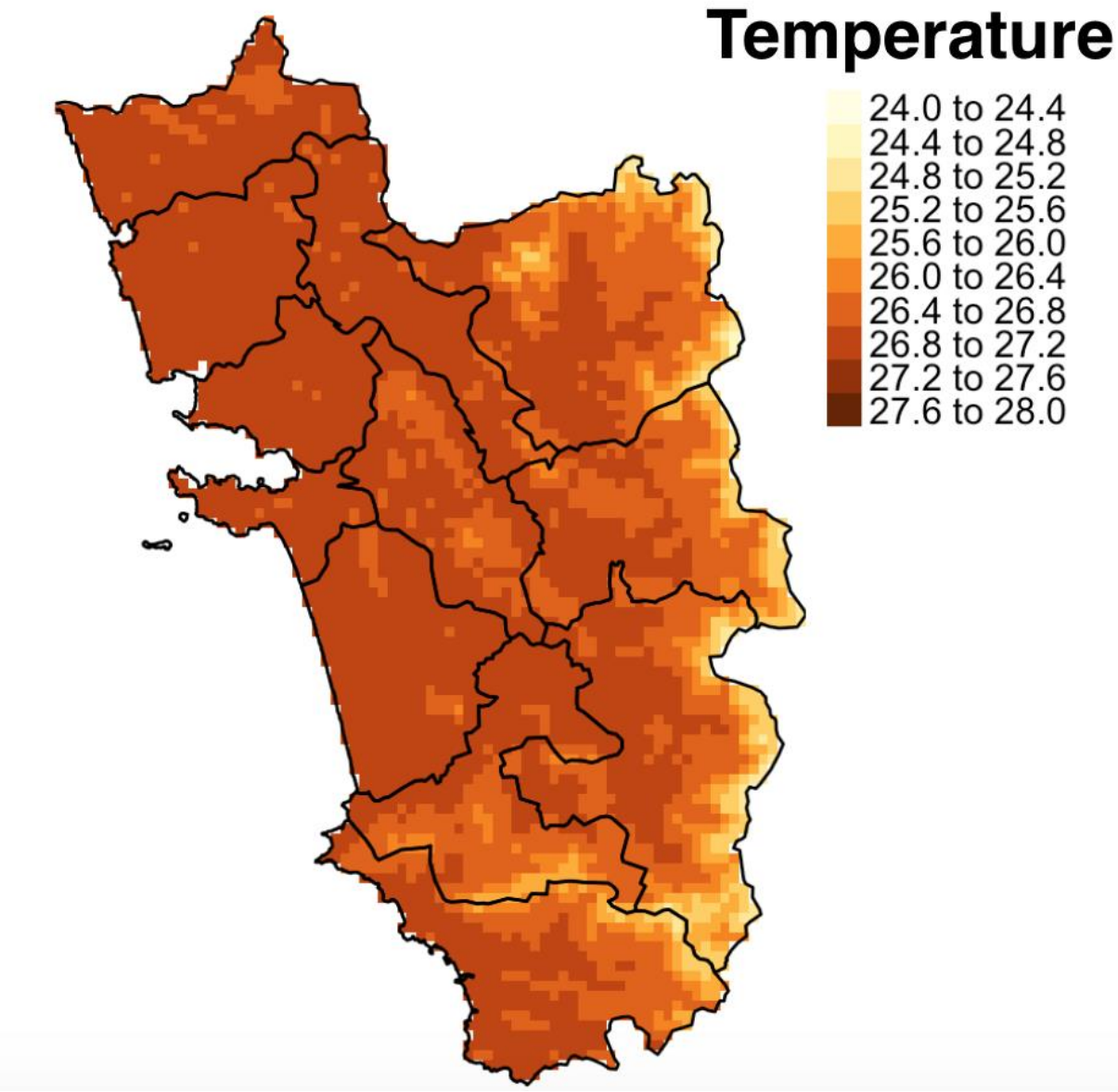

Figure 10: Long period average (1951-2014) spatial distribution of mean temperature (deg C) in Goa

Goa experiences a hot summer (April- June) followed by pleasant monsoon (June-September) season, temperatures temporarily rise again in the month of October, following pleasant winter months (November to March). Figure 11 shows the seasonal and monthly mean monthly temperature profile in the Goa based on the long-period mean temperature average over the period 1951-2014.

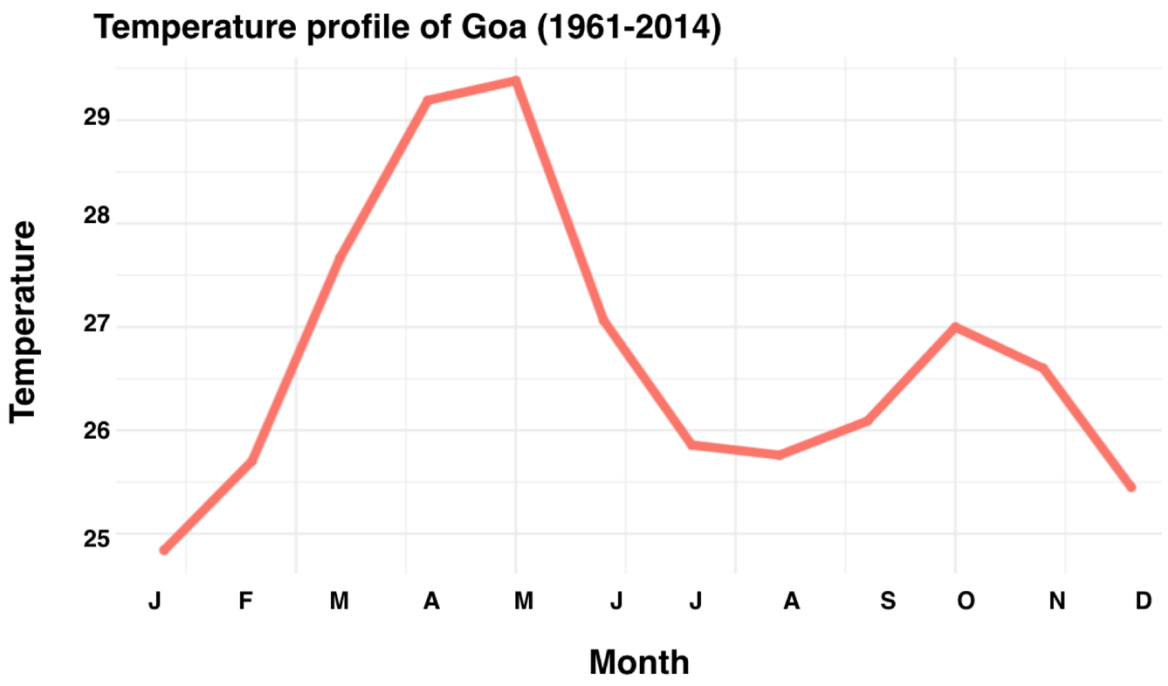

Figure 11: Long-period average (1951-2014) annual temperature profile in Goa

Rainfall Profile in Goa:

Average annual rainfall in Goa is about 3000 mm, which is about three times higher than the national average. Figure 12 shows the spatial distribution of annual rainfall in Goa. Analysis in Figure 13 is based on long-period (1951-2014) gridded precipitation data from the Indian Meteorological Department (Pai et al. 2014).

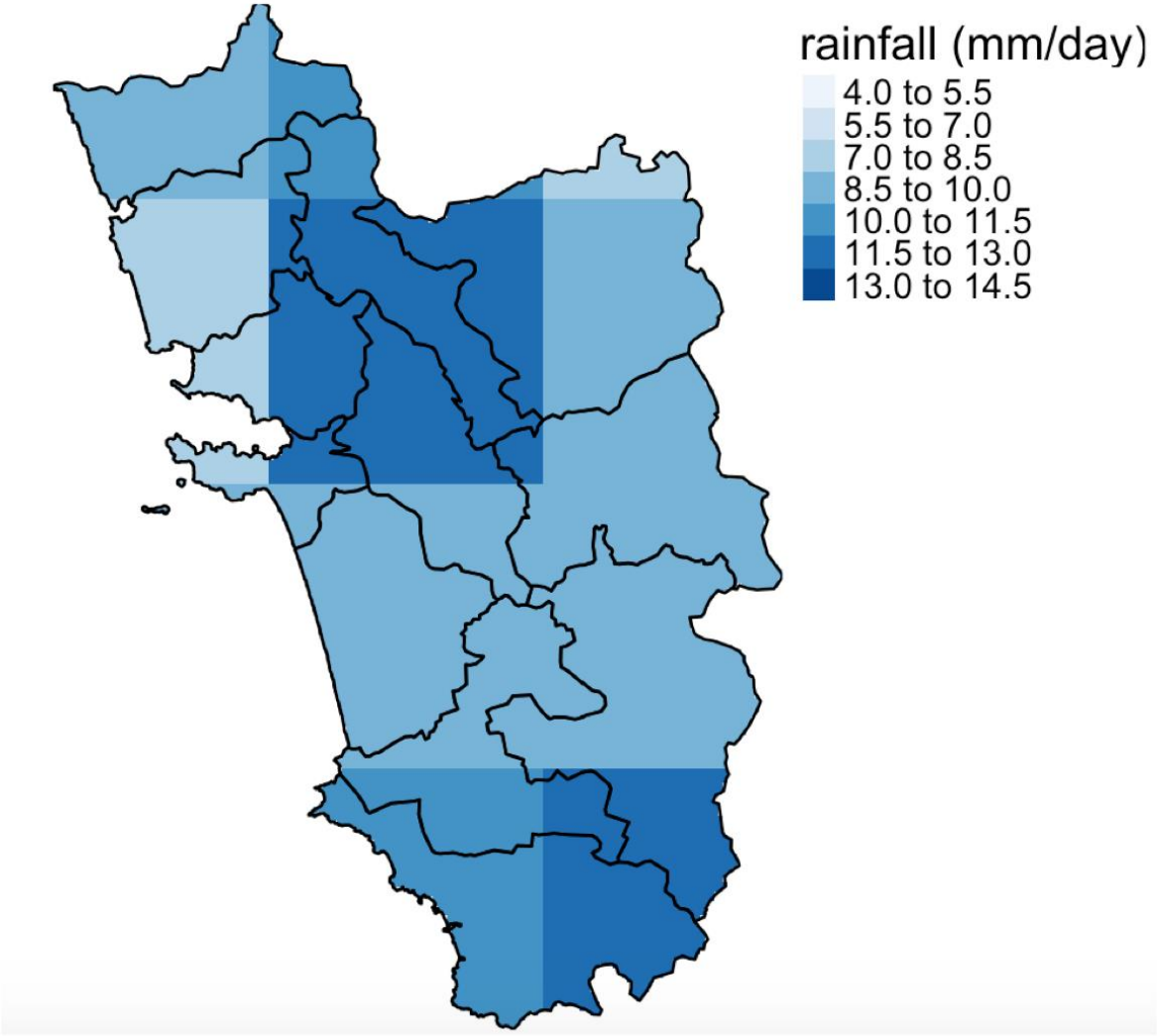

Figure 12:Long period average (1951-2014) spatial distribution of annual rainfall in Goa

Figure 13 shows the mean monthly rainfall profile in the state in monsoon, pre-monsoon and post monsoon months. Figure 13 shows that much of the rainfall in Goa takes place in the monsoon months, whereas winters are usually dry.

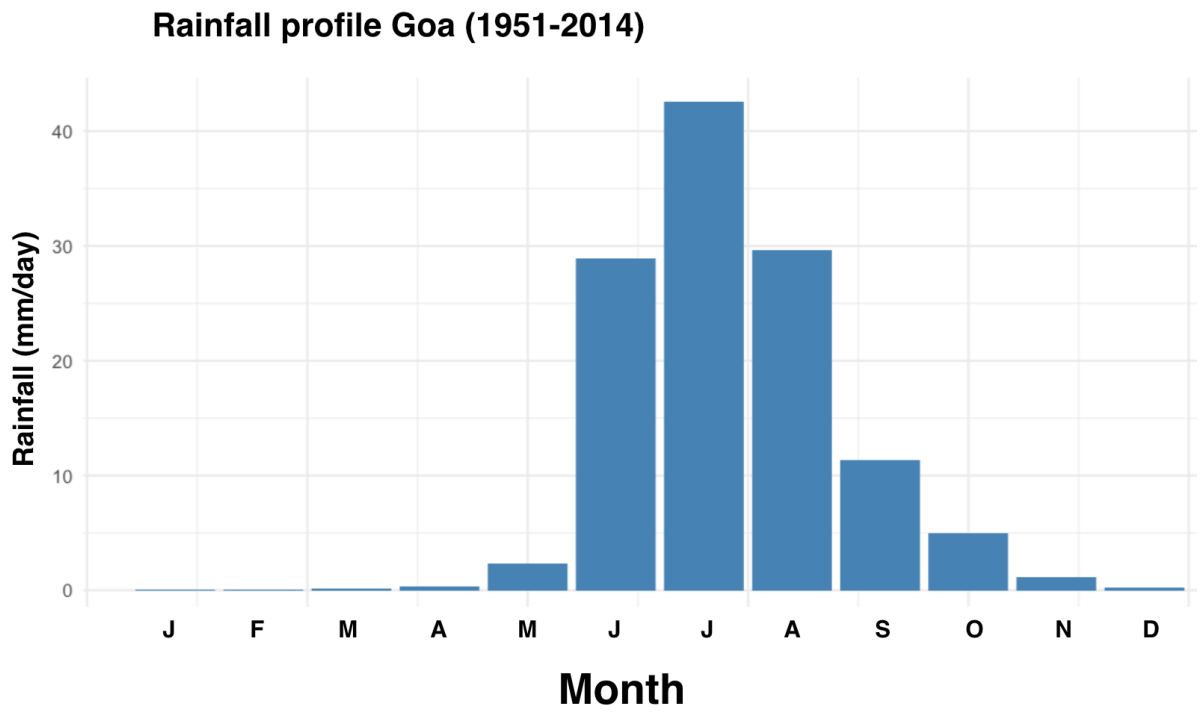

Figure 13: Long-period average (1951-2014) annual Rainfall profile in Goa

Geographical Features that influence climate in Goa

Goa has a peculiar geographic orientation with the Arabian Sea on the West and the Western Ghats (with increased height) on its eastern boundary. This makes the weather pattern very unique for Goa.

Observed Climate Change in Goa

Due to the build up of greenhouse gases in atmosphere, global temperatures are rising. It has been estimated that a warming of 2°C or even 1.5°C compared to the pre-industrial times is the threshold for dangerous climate change (IPCC, 2018). The global mean temperatures have already risen by about 1°C compared to pre-industrial times (Met Office, 2015). Indian sub-continent is also particularly warming since 1980s. As per IMD (2019) analysis, the annual mean temperature during 1901-2018 showed an increasing trend of 0.6°C/100 years. Climate change and its impact in Goa is not fully explored, however Kamat, 2013 and Kaur et al 2017 have explored some of the aspects of the observed climate change in Goa. The objective of this section is to investigate as to what extent changes in mean and extreme climate have occurred in the State of Goa during the period of 1901-2015.

Mean temperature trend in Goa is shown in Figure 14. It suggests that Goa is witnessing higher levels of temperature increase compared to the national average (IMD, 2013) as the mean temperature in Goa has increased by about 1°C over the period 1901-2018. Figure 3.10 also shows that much of the warming in Goa has been witnessed after 1970s.

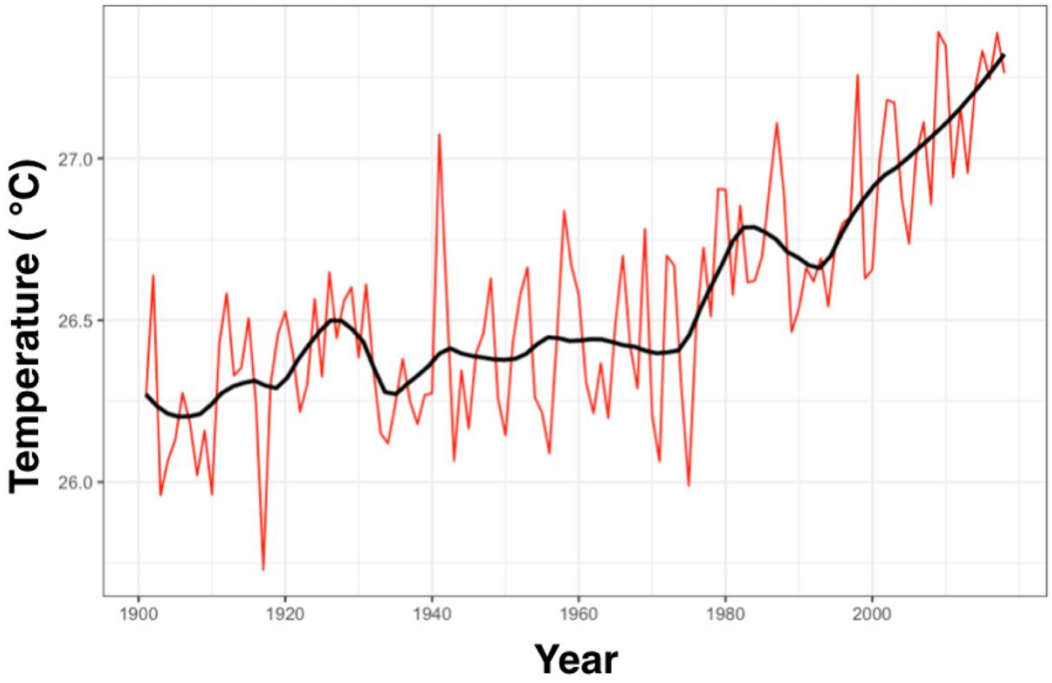

Figure 14: Observed changes in mean annual temperature in Goa (1901-2018)

Mean temperature change could be represented in terms of temperature anomalies as well. Change in mean temperature anomaly in Goa compared to the period 1960-1990 as shown in figure. It reiterates the conclusion that the mean temperature anomaly in Goa has increased by 1°C in the last century.

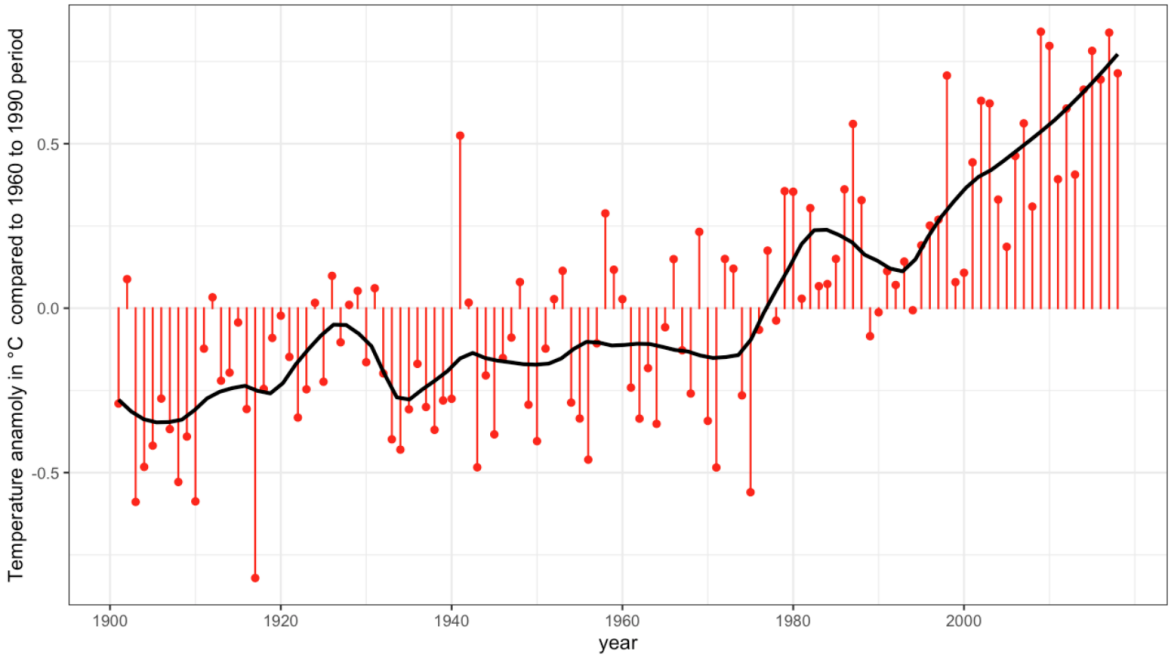

Figure 15: Mean annual temperature anomaly in Goa (1901-2018)

The maximum temperature and minimum temperature trend from station-based data for Panajim, Dabolim and Margoa stations were also analysed. One of the results from the Panjim station is shown below. Station based data also suggests large temperature rise in Goa as analysed from the gridded dataset.

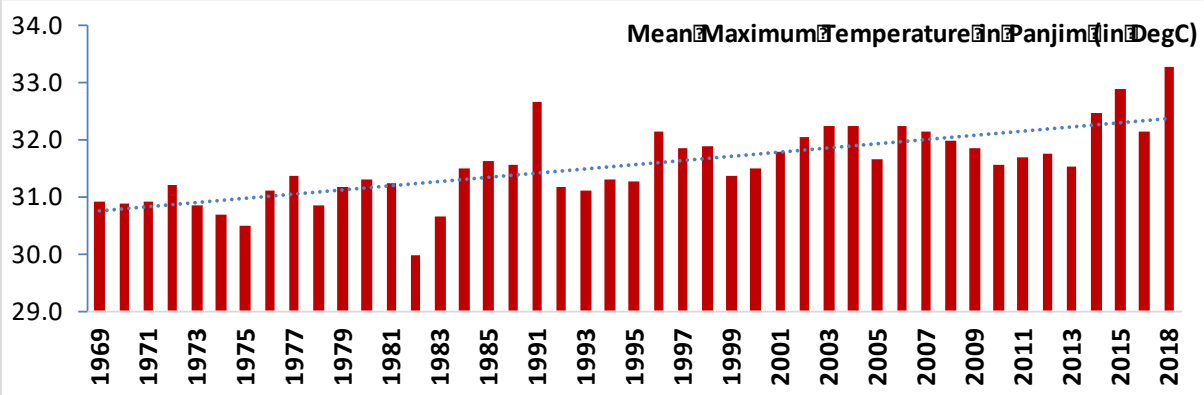

Figure 16:Mean Maximum Temperature trend as available from Panjim station

Similarly, mean annual rainfall trend in Goa has also been plotted. It shows that mean annual rainfall in Goa has increased by about 68% over the last century. Results are supported by mean annual rainfall trend in North Goa as reported by Kaur et al 2017, where mean annual rainfall in North Goa is found to have increased from 3000 mm in 1901 to 5000 mm to 2015 (an increase of 66%).

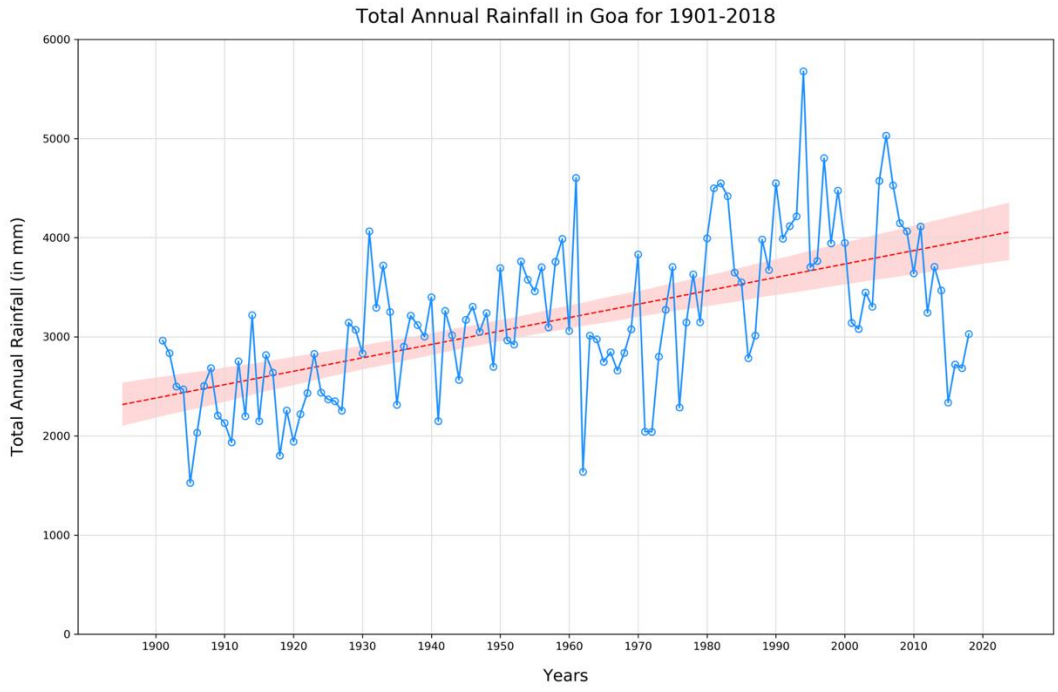

Figure 17: Long-term rainfall trend in Goa (1901-2018)

The rainfall anomaly (percentage departure from the 1960-1990 mean) for the period 1901-2015 shows that mean annual rainfall in Goa has consistently increased over the last 100 years.

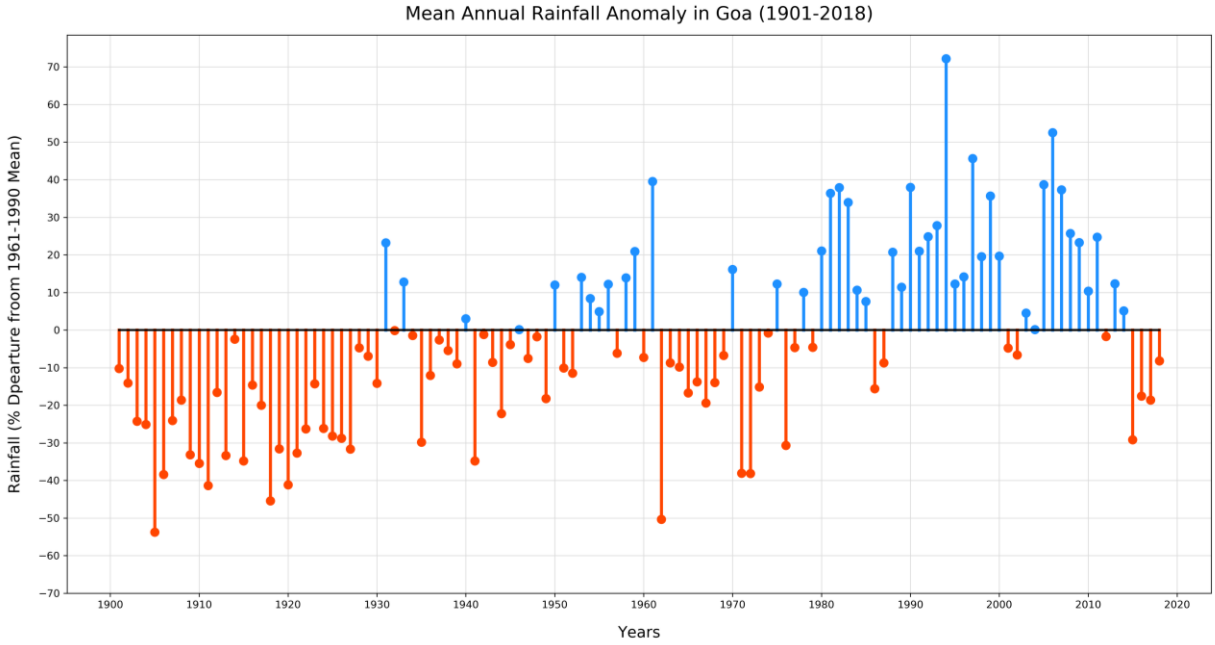

Figure 18: Mean annual rainfall anomaly in Goa (1901-2018)

The annual rainfall trend from station based data for Panajim, Dabolim and Margao stations. One of the results from the Panjim station is shown below. Station based data also suggests rise in rainfall as analysed from the gridded dataset.

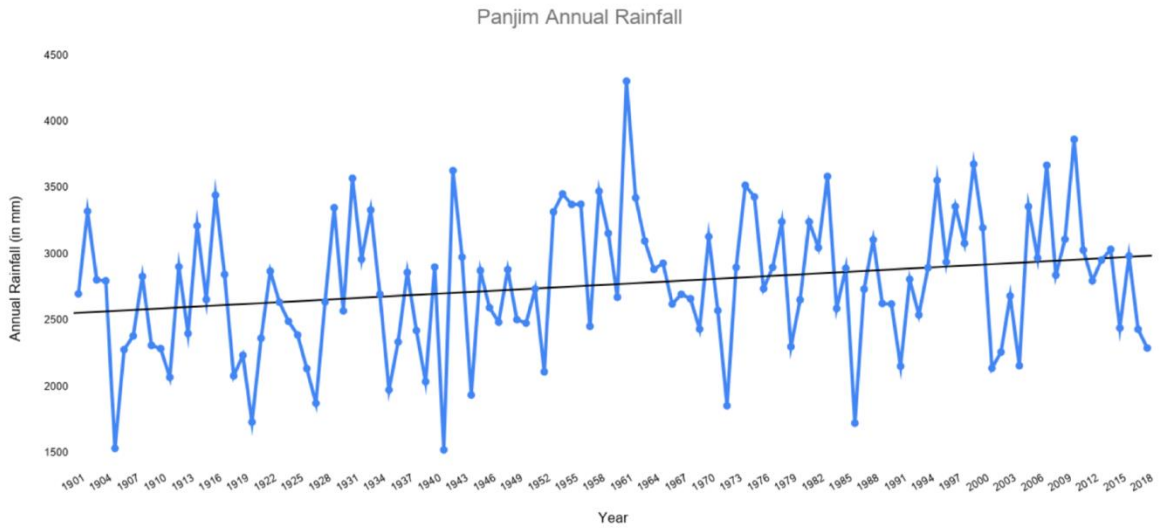

Figure 19: Annual rainfall trend from Panjim station

Studies (Goswami et al 2006; Ghosh et al 2012) based on the observed precipitation records of Indian Meteorological Department (IMD) have shown that the occurrences of extreme

precipitation events and their variability have already gone up in many parts of India. To quantify the observed changes in extreme rainfall events over Goa by using the daily precipitation data from IMD. Rainfall in India is categorized as the following categories and these extreme Rainfall categories are obtained from Bhatla et al., 2016.

Table 8: Classification of rainfall events based on daily rainfall

IMD Classification		**IMD Classes Regrouped as Bhatla et al 2019, and used for analysis in this report**	
Rainfall Categories	**Daily Rainfall (mm)**	**Rainfall Categories**	**Daily Rainfall (mm)**
No Rain	0	No rainfall	0-2.4
Very light rain	0.1-2.4		
Light rain	2.5-7.5	**Category 1**	**2.5-64.4**
Moderate rain	7.6-35.5		
Rather heavy rain	35.6-64.4		
Heavy Rain	64.5-124.4	**Category 2**	**64.5-124.4**
Very Heavy rain	124.5-244.5	**Category 3**	**>124.5**
Exceptionally heavy rain	≥244.6		

Source: Bhatla et al 2016

The frequency of light and moderate rainfall events is declining over the last century, whereas the frequency of extreme rainfall events in increasing in Goa over the last century. No. of rainy days experiencing Category 1, rainfall has declined over the period 1901-2015. Whereas, no. of rainy days experiencing heavy rainfall i.e. category 2, rainfall has increased by about 60%. On the other hand, Category 3 rain fall days, which denotes rainy days with extreme rainfalls (very heavy and exceptionally heavy) have increased by an alarming more than 100%. It is interesting to note that it is the category 1 and 2, rainfall events (moderate to light heavy rainfall) that nourish life-forms and ecosystems, whereas category 3 rainfall events (very heavy and exceptionally heavy) create devastation and chaos to life-forms and ecosystems. Increasing frequency of very heavy and exceptionally heavy rainfall events in Goa is one of the key

impacts of climate change witnessed in the state. **Goa state is already vulnerable to flooding, increasing heavy rainfall trend makes the state even more vulnerable to this hazard.**

Figure 20: Declining moderate rainfall days and increasing very heavy and exceptionally heavy rainfall days in Goa

Goa state is organized in 12 Taluks, Figure below shows how each of the Taluks in the state are facing the impact of climate change in terms of increasing temperature anomalies over the last century.

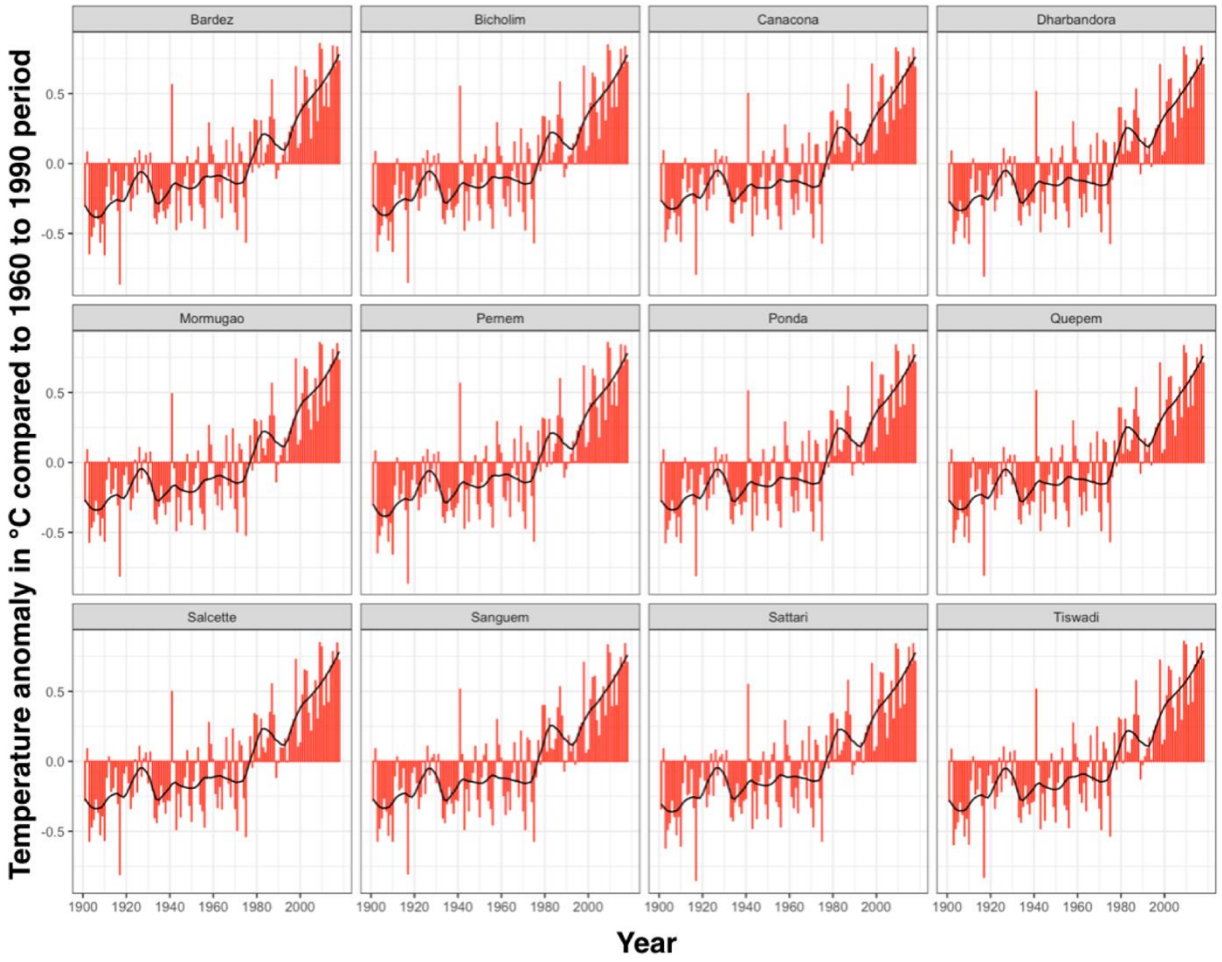

Figure 21: Taluk-wise observed mean annual temperature anomalies (°C) in Goa over 1901-2015

Projected Climate Change in Goa

Climate change projections in Goa in the 21st century based on high resolution regional climate models (RCPs) have been carried out. The projected climate change scenarios (temperature and rainfall) are for the two scenarios of RCP8.5 and RCP4.5. Under RCP8.5 scenario atmospheric CO2 concentration rises to 940 ppm by 2100, whereas under RCP4.5 scenario atmospheric CO2 concentration rises to 538 ppm by 2100.

From the analysis the mean temperature projections for the state of Goa from 1901-2100 under two scenarios of RCP4.5 and RCP8.5 are given below. Under the RCP8.5 scenario temperature rises by 4.5°C compared to the base of 1901-1950, however if the GHG emissions are controlled to RCP4.5 scenario then Goa witnesses a mean temperature rise of only about 2.5°C compared to 1901-1950 base.

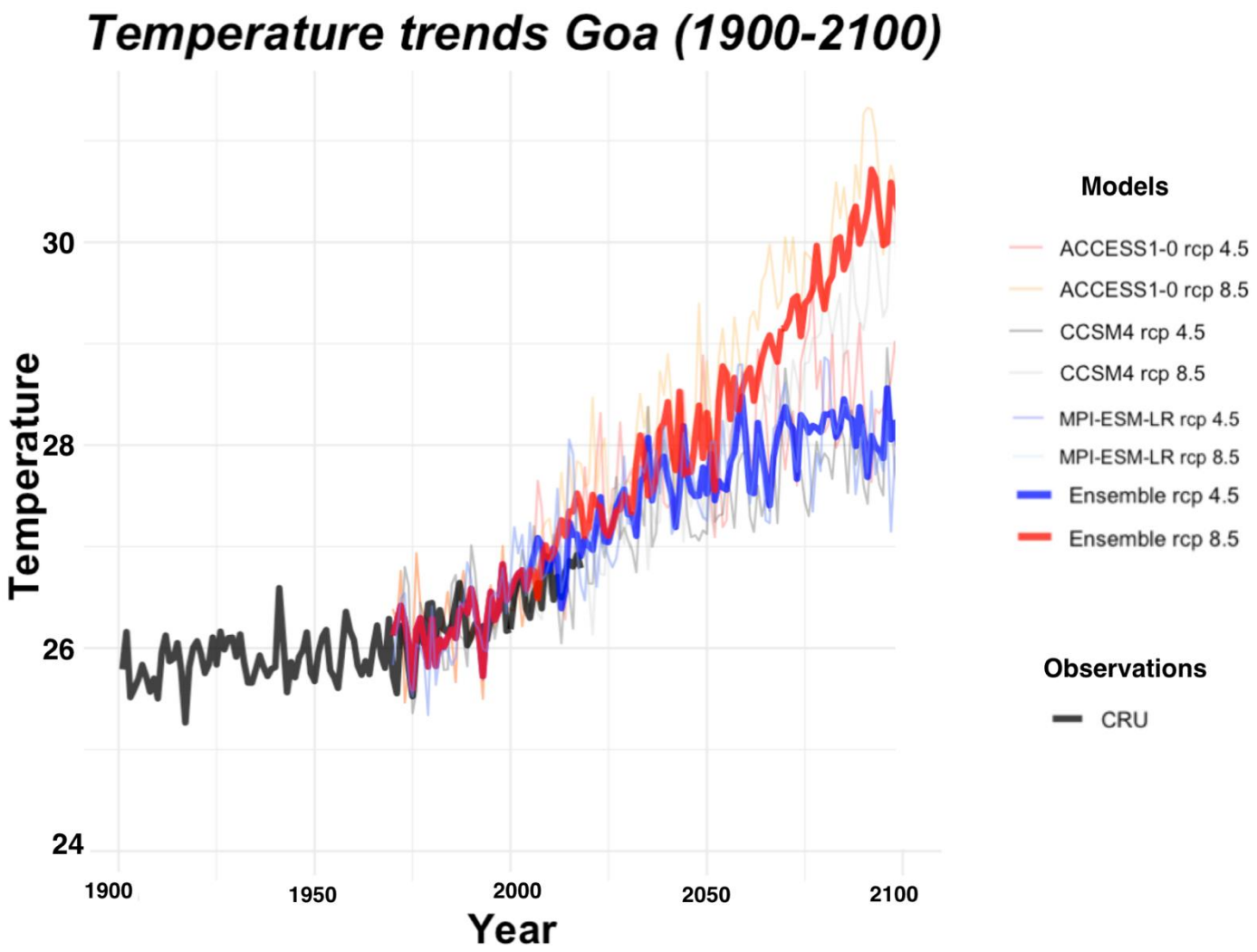

Figure 22: Projected mean temperature trend (deg C) in Goa under different climate change scenarios

The mean annual rainfall projections for the state of Goa from 1901-2100 shows that generally annual rainfall is projected to decrease in Goa in the 21st century, however the variability in rainfall projections for Goa state are very high.

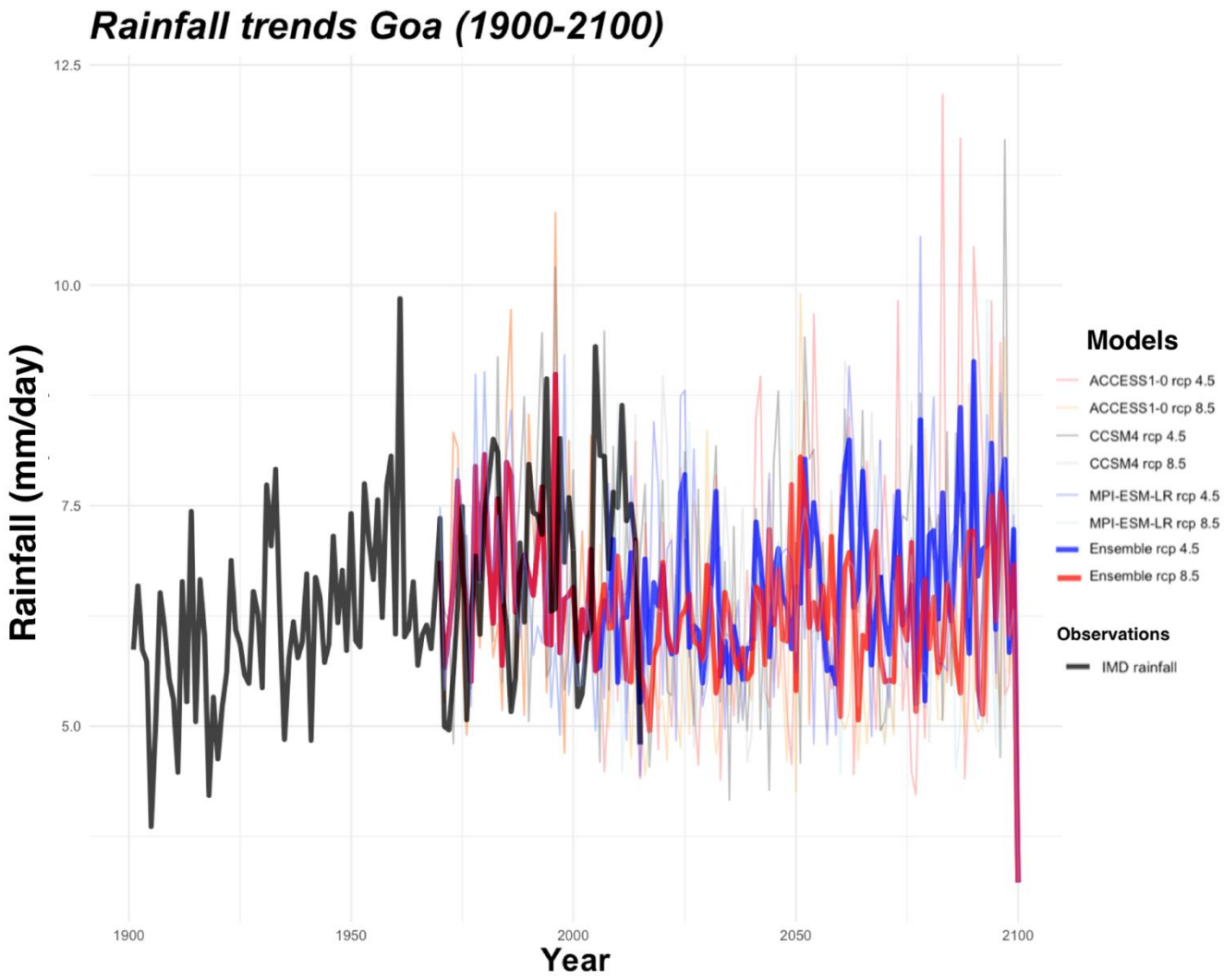

Figure 23: ***Projected rainfall trend (mm/day) in Goa under different climate change scenarios***

Krishnan et al (2013) based on simulations from the 20-km ultra high-resolution model projected reduced rainfall over the Western Ghats in the 21st century. It is argued that a stabilization (weakening) of the summer monsoon Hadley-type circulation in response to global warming can potentially lead to a weakened large-scale monsoon flow thereby resulting in weaker vertical velocities and reduced orographic precipitation over the narrow Western Ghat mountains by the end of the twenty-first century. The findings of this modelling are aligned to the same.

It should, however be noted that precipitation projections in the 21st century are less reliable compared to temperature projections. Chaturvedi et al 2012 based on their analysis find that all India precipitation projections have larger uncertainties as evident from the large spread of the precipitation change projections in the 21st century. Further Taylor diagram analysis suggests higher confidence for the temperature projections and relatively low confidence for the precipitation projections from 21 CMIP5 models (See figure 3.20).

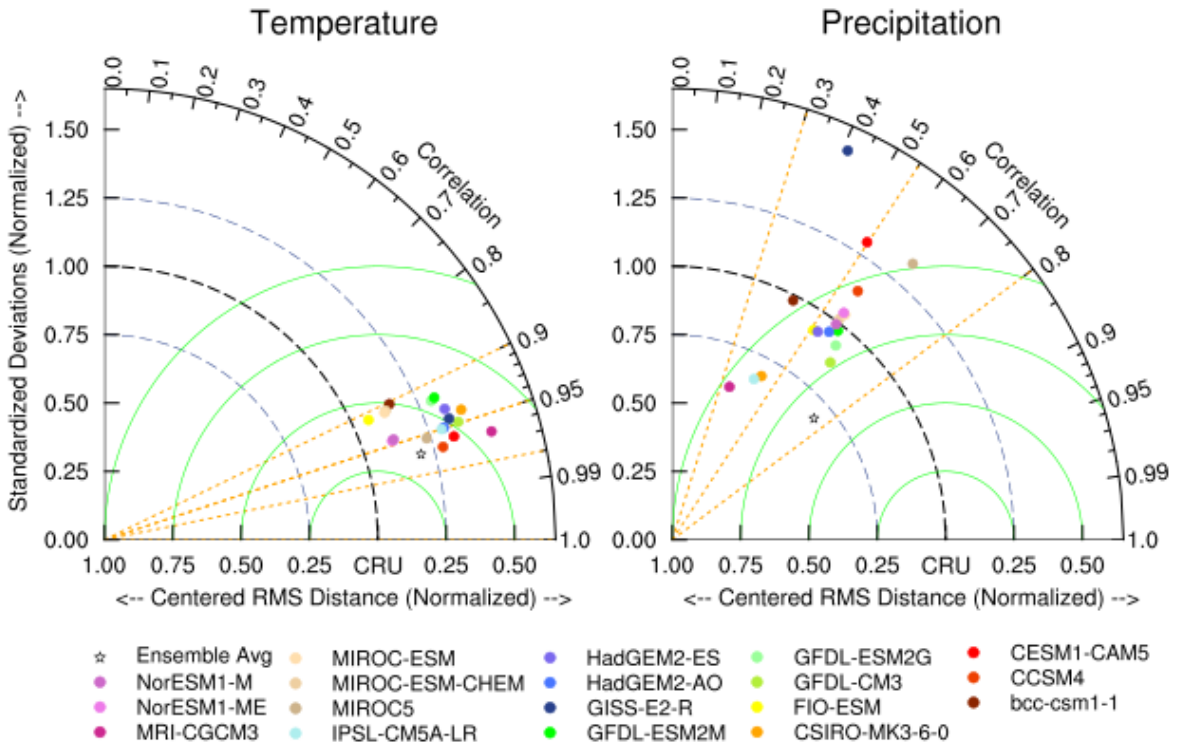

Figure 24: Predictability of temperature variable in the 21st century is high whereas the predictability of precipitation variable is lesser

These findings are also supported by the earlier findings involving the CMIP3 model experiments, both at global scales (Solomon et al 2007), as well at all India level precipitation projections (Krishnakumar et al 2010).

Following three time-slices has been used for climate change projections: 2021-2050 (Short-term); 2046-2075 (Mid-term); and 2071-2100 (Long-term).

Figure below shows the future mean annual temperature projections in the short term, medium term and long-term. As per Figure 3.21, mean annual temperature in Goa increases to 28.3°C by 2035, and to 30.3°C, compared to the present annual temperatures (1985-2015) of 26.80°C.

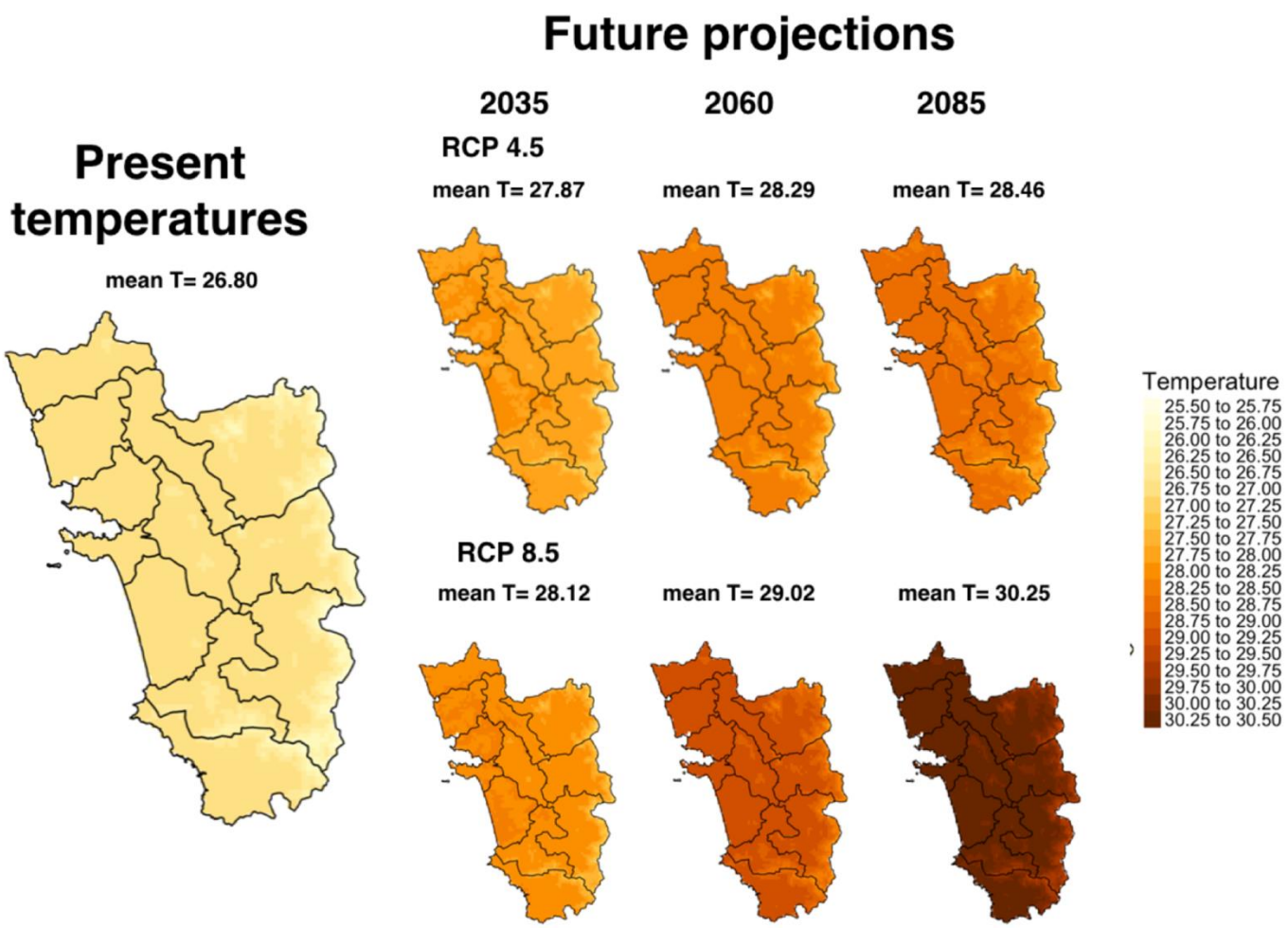

Figure 25: CORDEX model ensemble based mean temperature change (°C) projected for Goa for the year 2030s (2021–2050), 2060s (2046–2075) and 2080s (2070–2099) relative to the Present temperatures (1985-2015)

Figure below shows the future mean annual rainfall projections in the short term, medium term and long-term. Annual mean rainfall in Goa decreases under high emission scenarios but

remains largely stable under moderate emissions scenario.

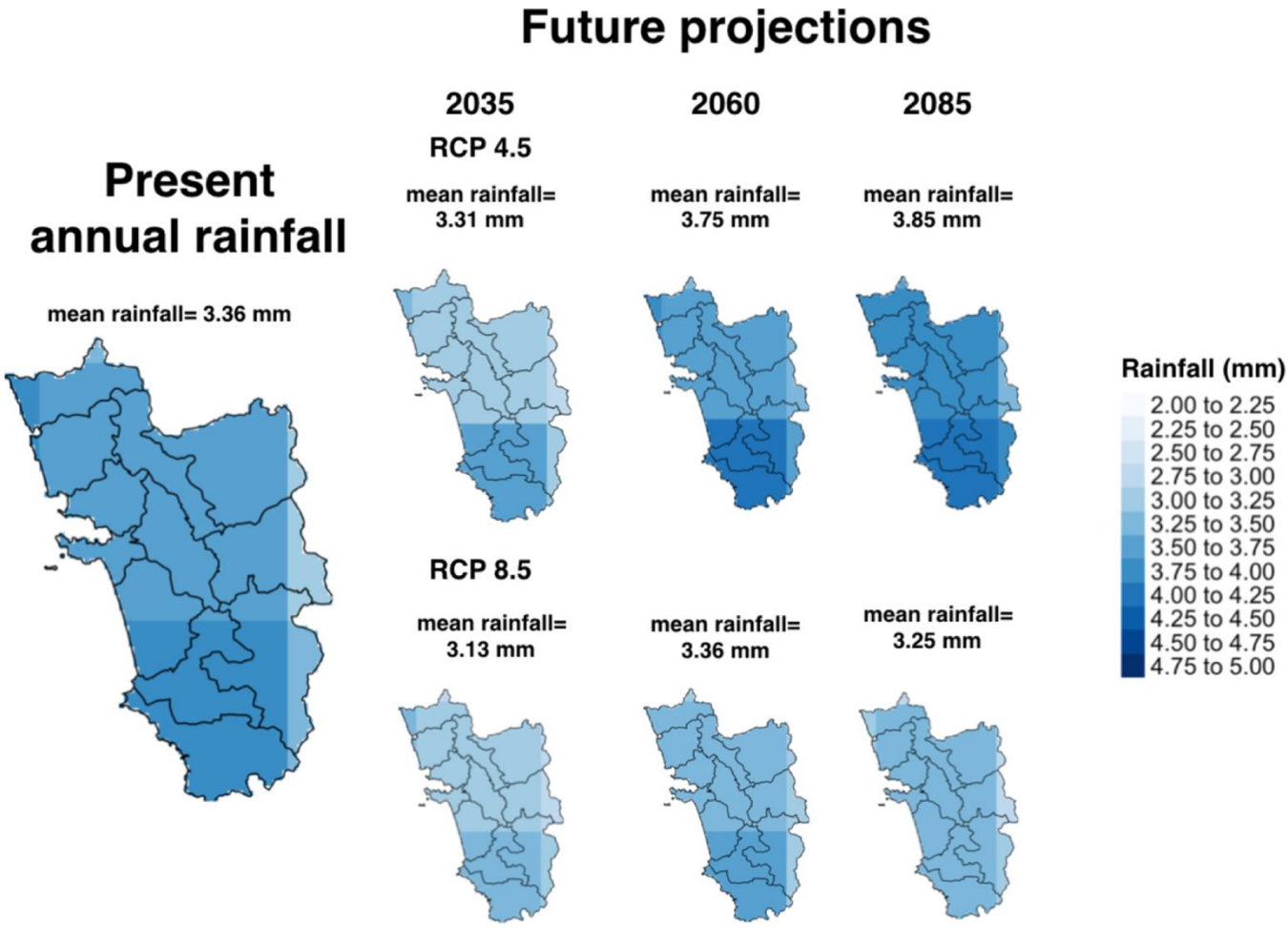

Figure 26: CORDEX model ensemble based mean daily rainfall change (mm) projected for Goa for the year 2030s (2021–2050), 2060s (2046–2075) and 2080s (2070–2099) relative to the Present temperatures (1985-2015)

Projection of Extreme Temperature

Extreme temperatures are projected to increase under climate change scenarios. For Goa, it is projected that by the year 2040, maximum temperatures of 40°C or more will become commonplace, minimum temperatures in Goa are also expected to increase by 3-7°C.

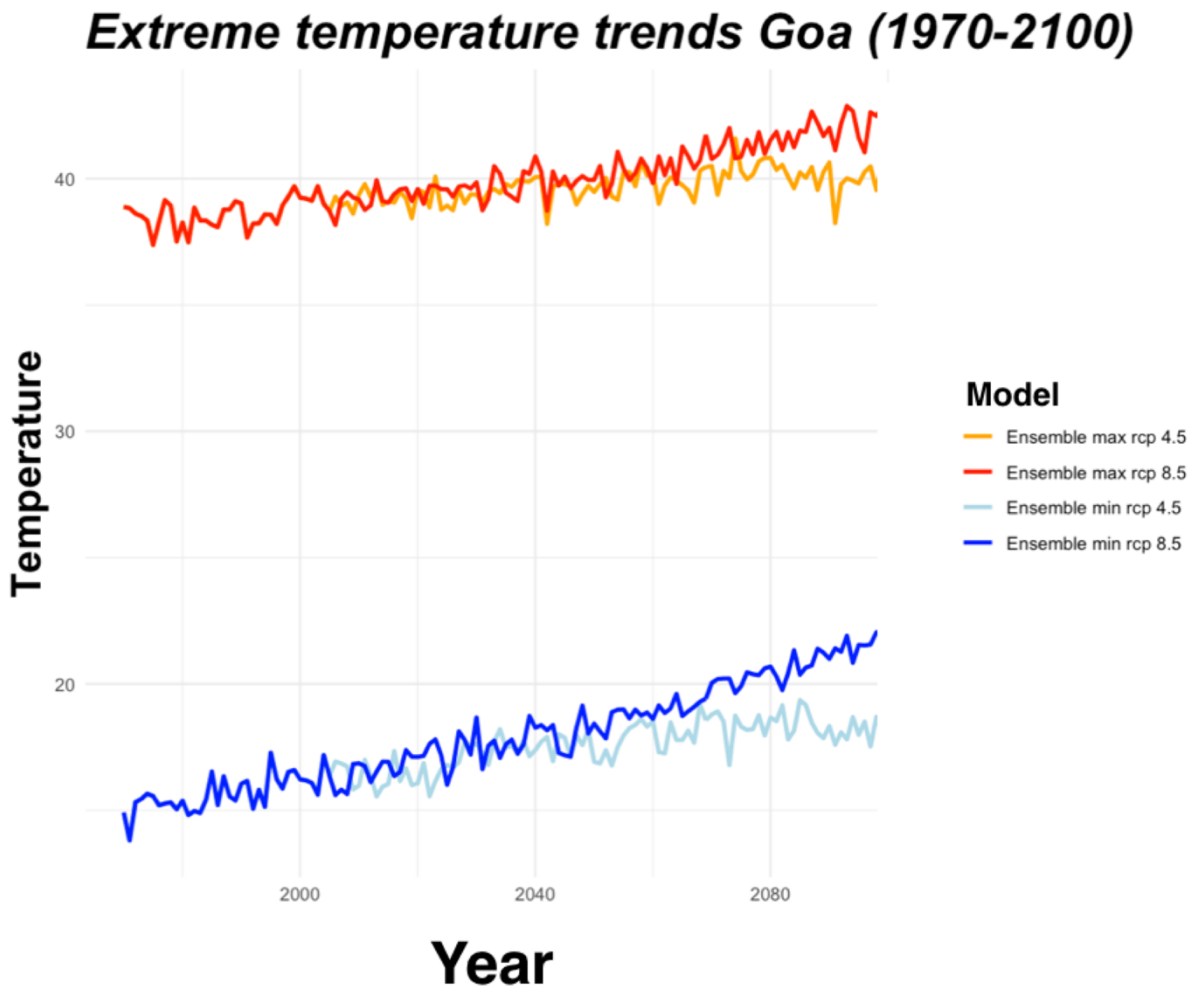

Figure 27: Projected trend in minimum temperature and maximum temperature in Goa in the 21st century

Projection of Extreme Rainfall

IPCC special report on weather extremes (IPCC, 2012) project likely increase in the frequency of heavy precipitation in the 21st century over many areas of the globe. We quantify the expected future change in extreme rainfall events over India by using the daily precipitation data from the multiple model ensemble of the CORDEX models. Very heavy rainfall events

will increase in Goa in the 21st century, under both RCP4.5 and RCP8.5 scenarios.

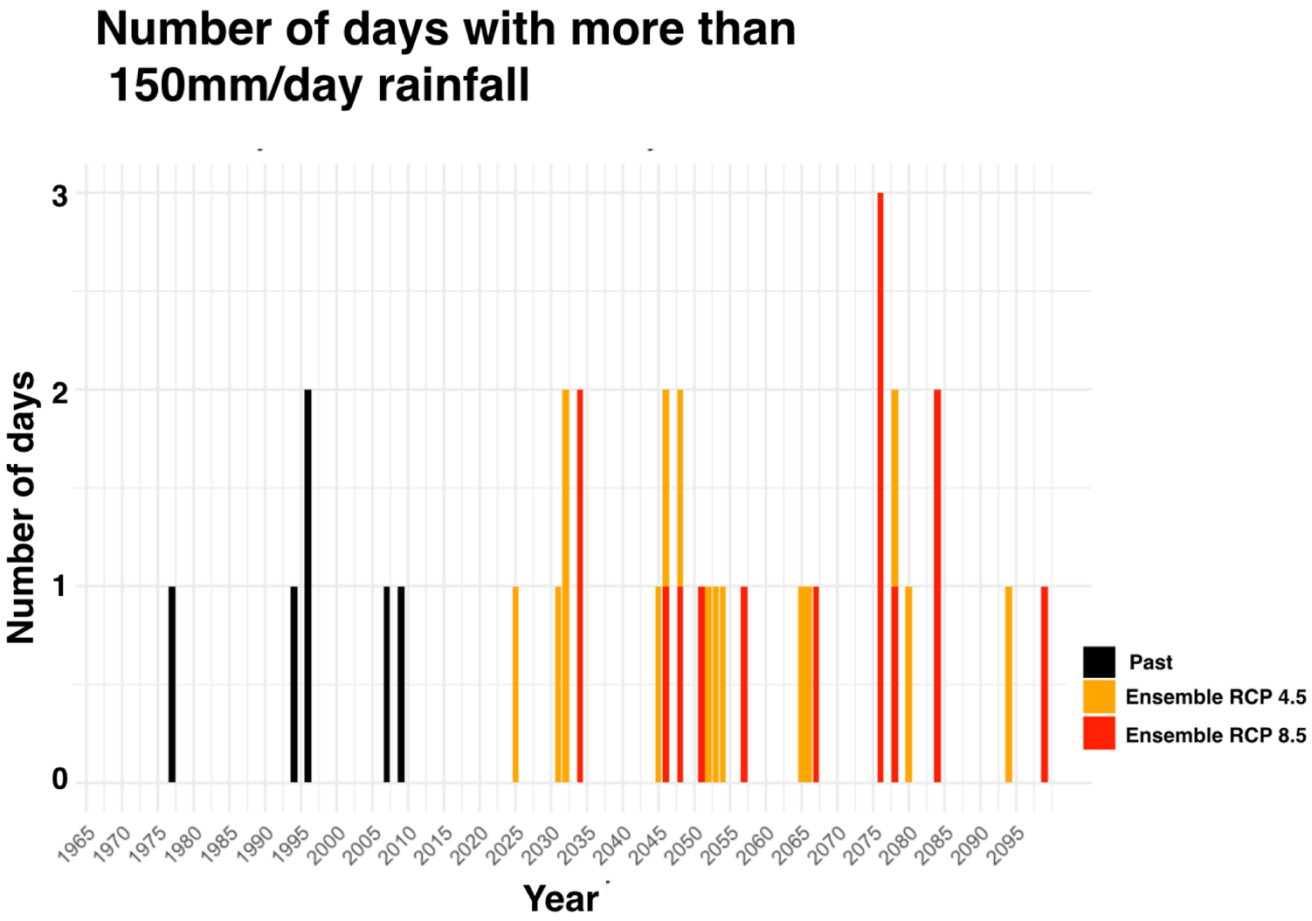

Figure 28: Rising frequency of very heavy extreme rainfall events in climate change scenarios

Similarly, exceptionally (rare) very heavy extreme rainfall events which are rare and exceptional in today's climate will become commonplace in climate change scenarios of RCP4.5 and RCP8.5 (see Figure 3.25).

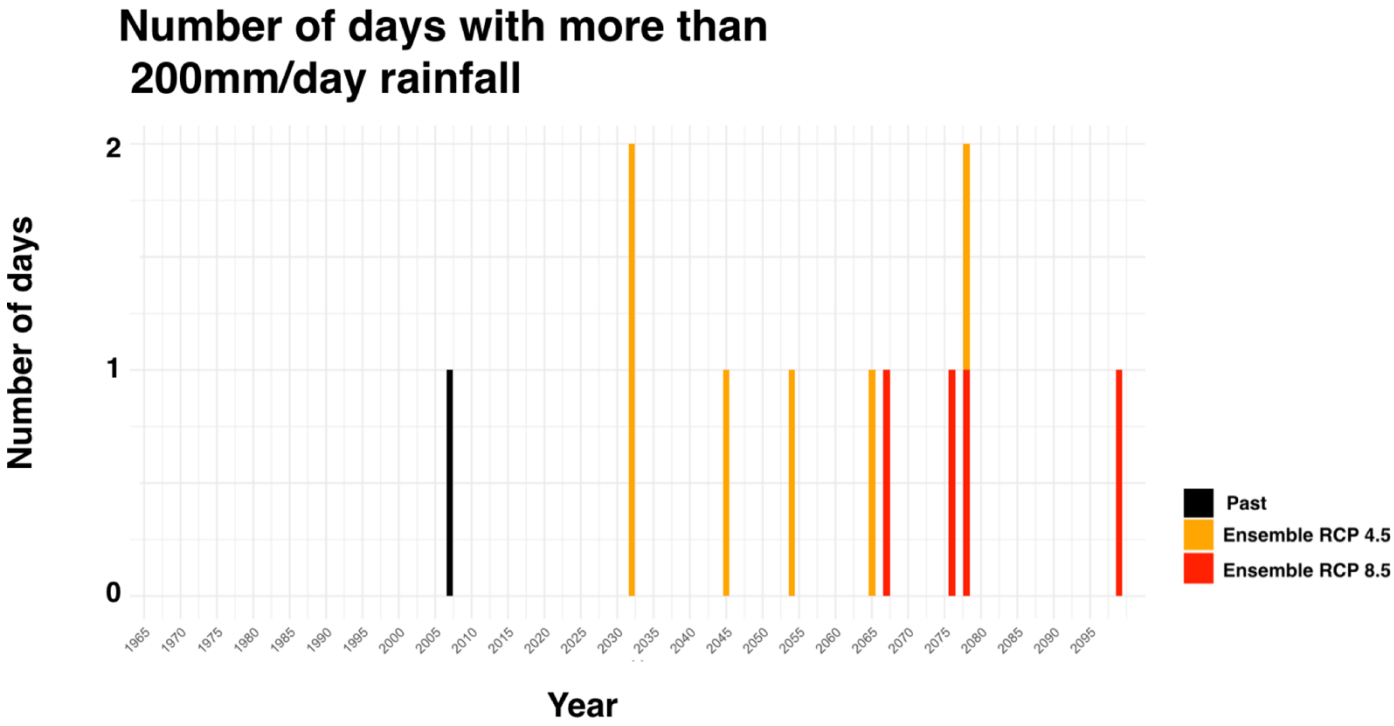

Figure 29: Abundance of exceptionally (rare) very heavy extreme rainfall events in climate change scenarios

Analysis of flood vulnerability in Goa

Flood vulnerability in Goa under current climate as well as under future climate is spatially mapped using the high-resolution digital representation of orography based on SRTM Digital Elevation Model (DEM), published by the CGIAR-Consortium for Spatial Information (http://srtm.csi.cgiar.org), with a cell size (spatial resolution) of 90 m, is used (Farr et al.2007, Reuter et al. 2007). On the basis of elevation, Goa is categorized in multiple elevation zones, elevation zone of 0-5 meter is considered to be most vulnerable to flooding from multiple hazards including sea level rise, and extreme precipitation events. The taluks of Salcete, Tiswadi, and Bardez most vulnerable to flooding related hazards.

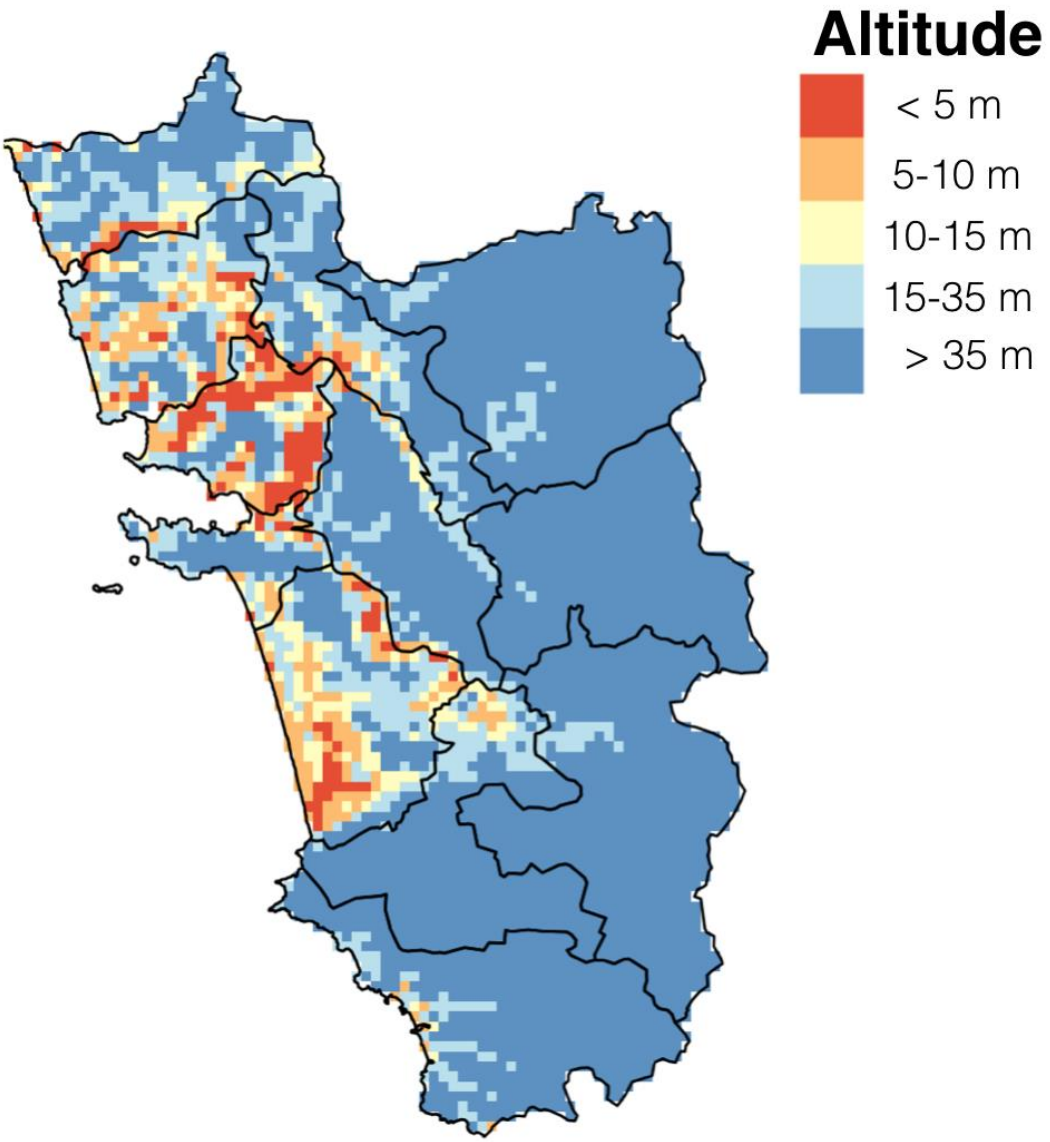

Figure 30: ***Flood vulnerability map of Goa***

Taluk-wise climate change projections for Goa are provided in table below.

Table 9: Taluk wise projection of mean temperature (°C) under different climate change scenarios

		RCP 4.5			**RCP8.5**		
Taluk	Present (1985-2015)	2035	2060	2085	2035	2060	2085
Bicholim	26.90	27.97	28.38	28.56	28.21	29.12	30.34
Bardez	26.93	27.99	28.41	28.59	28.23	29.14	30.37

Tiswadi	26.94	28.01	28.42	28.60	28.25	29.16	30.38
Pernem	26.90	27.97	28.38	28.56	28.21	29.12	30.34
Ponda	26.86	27.94	28.35	28.53	28.18	29.08	30.31
Sattari	26.70	27.78	28.18	28.36	28.03	28.93	30.15
Canacona	26.77	27.85	28.25	28.43	28.09	28.99	30.22
Salcette	26.93	27.99	28.41	28.59	28.23	29.14	30.37
Quepem	26.79	27.87	28.27	28.45	28.11	29.01	30.24
Mormugao	26.92	27.99	28.40	28.58	28.23	29.14	30.36
Sanguem	26.67	27.75	28.14	28.32	27.99	28.89	30.12
Dharbandora	26.71	27.79	28.19	28.37	28.03	28.94	30.16

Table 10: Taluk wise projection of mean rainfall (mm/day) under different climate change scenarios

		RCP 4.5			**RCP8.5**		
Taluk	Present (1985-2015)	2035	2060	2085	2035	2060	2085
Bicholim	6.75	6.46	6.86	7.02	6.25	6.53	6.50
Bardez	6.76	6.47	6.87	7.03	6.26	6.53	6.50
Tiswadi	6.75	6.46	6.86	7.02	6.25	6.53	6.50
Pernem	6.80	6.50	6.90	7.02	6.29	6.52	6.46
Ponda	6.75	6.46	6.86	7.02	6.25	6.53	6.50
Sattari	6.73	6.44	6.84	7.00	6.24	6.51	6.48
Canacona	7.16	6.78	7.27	7.25	6.61	6.77	6.52
Salcette	6.94	6.60	7.05	7.13	6.42	6.64	6.51
Quepem	7.15	6.77	7.26	7.25	6.60	6.77	6.52
Mormugao	6.75	6.46	6.86	7.02	6.25	6.53	6.50
Sanguem	6.93	6.60	7.06	7.12	6.43	6.63	6.45
Dharbandora	6.64	6.37	6.77	6.93	6.18	6.44	6.38

5. Climate Vulnerability Assessment

5.1. Vulnerability assessment

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as "the propensity or predisposition to be adversely affected" [1], which encompasses the basic components of exposure, sensitivity, and adaptive capacity. Key sector-specific indicators have been utilized to assess the sensitivity and adaptive capacity of the sector.

The coastal areas of the country, face grave risks due to climate change. There is the risk of cyclones and tsunamis, the intensity of which is predicted to rise. Rising sea levels, which could flood land (including agricultural land) and cause damage to coastal infrastructure and other property, pose another threat.

Coastal Vulnerability: UNDP predicts, Goa stands to lose a large percentage of its land area, including many of its famous beaches and tourist infrastructure, which are very significant to states' socio-economic status. A one-metre rise in sea level, it is estimated, will affect 7 percent of Goa's population and cause damage to the tune of Rs 8,100 crore.[3] Because of this, it becomes essential to understand the vulnerability to different parts of the 100km vast coastline of Goa.

The multi-hazard vulnerability assessment of the coastline of Goa carried out by NIO in 2014 provides a reasonable assessment of coastal flooding and inundation for Talukas along the coast. This is accomplished by using seven physical and geologic risk variables characterizing the vulnerability of the coast, including historical shoreline change, rate of relative sea-level change, coastal regional elevation, coastal slope, mean tidal range, significant wave height, and geomorphology using conventional and remotely sensed data, in addition to two socio-economic parameters: population and tourist density data. The results of this composite vulnerability index-based study suggest that [4] the 30 km of the coastline of the talukas of Salcete, Bardez, and Tiswadi has a coastal regional elevation of fewer than 35 m and is at the highest risk due to sea-level rise and flooding. Bardez and Salcete talukas have both experienced erosion rates of more than 0.6 m/year while the erosion rate for Tiswadi was found to be above 0.3 m/year. These are also the most populated talukas and most prominent tourist spots, further increasing the risk of erosion in these taluks.

Table 11: Taluka and District wise Population of the State[5]

Taluka/District wise Household Population

[3] Climate change adaptation activities in India: https://www.undp.org/content/dam/india/docs/climate_change_adaptation_activities_in_india_part_i.pdf

[4] Multi-hazards Coastal Vulnerability Assessment of Goa, India, using Geospatial Techniques, NIO, 2014

[5] Economic Survey 2017-18

State/ District/ Taluka	Number of HH	Total population	% to Total population	Average Family Size
GOA	343611	1458545	100.00	4.24
North Goa				
Pernem	17248	75747	5.19	4.39
Bardez	57147	237440	16.28	4.15
Bicholim	22414	97955	6.72	4.37
Tiswadi	42241	177219	12.15	4.20
Satari	14367	63817	4.37	4.44
Ponda	38349	165830	11.37	4.32
TOTAL	191766	818008	56.08	4.27
South Goa				
Mormugao	35702	154561	10.60	4.33
Salcete	71717	294464	20.19	4.11
Quepem	19119	81193	5.57	4.25
Sanguem	15068	65147	4.46	4.32
Canacona	10239	45172	3.10	4.41
TOTAL	151845	640537	43.92	4.22

**Source: Office of Registrar General and Census Commissioner, India.

Other Physical Vulnerability

The riverine water system of Goa and the creeks and backwaters are vulnerable to high-intensity precipitation scenarios predicted for the state. The brackish water areas have very rich ecosystems and exist along creeks and rivers. Some of them are protected by sluice and gate systems whereas others are at the risk of ingress of saline water due to climate change. Groundwater extraction is not well regulated and intrusion of groundwater is likely to increase Saltwater intrusion into the groundwater system. As the sea level rises this problem will be further exasperated. The high groundwater levels in certain areas pose the challenge of water percolation capacity of the soil. Thus, increasing the vulnerability of these areas like Panaji.

Mangroves are an important part of the marine ecosystem. This is under threat due to rising temperatures. The increased seawater temperature is impacting the fish availability as well.

Economic Vulnerability

Quantification of the economic loss due to climate change has not been ascertained so far for Goa, however, based on the national, international and sectoral developments published the economic activities in Goa are certainly vulnerable to climate change.

South Asia on average could lose nearly 2% of its GDP by 2050, rising to a loss of nearly 9% by 2100 under the BAU scenario (Ahmed and Suphachalasai, 2014).

About 4% of the state lives below the poverty line which is much lower than many other states in India. The majority of its population is urban with a high literacy rate of about 82%. Economic activity in the state is dominated by agriculture and the allied sector, tourism, and mining.

Tourism in general and in Goa specifically, if highly dependent on natural resources. Changes in water availability, biodiversity loss, reduced landscape aesthetic, increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases will all impact tourism to a varying degree. The risk of irreversible loss of many marine and coastal ecosystems increases with global warming, especially at 2°C or more.

5.2. Impact and Vulnerability of Vulnerable Group to Climate Change

The IPCC Special Report on Global Warming of 1.5°C emphasized that disadvantaged and vulnerable populations including indigenous peoples and certain local communities are at disproportionately higher risk of suffering adverse consequences with global warming of 1.5°C and beyond.

Coastal regions are directly vulnerable to rising sea levels, local and regional land subsidence, storm surges from severe storms, and changing intensities and frequencies of precipitation events (Hoegh-Guldberg et al., 2018; Koop and van Leeuwen, 2017). In the context of Goa, communities living in low lying areas, informal settlements like slum population, people with disabilities and those whose livelihood dependents mainly on khazan lands are in particular the immediate and most vulnerable groups.

Goa has one of the lowest slum populations in the country of about 2% of which 90% is found in Mormugao. Mormugao houses the only commercial port of Goa and has been identified to be at moderate risk due to climate change in the study carried out by NIO mentioned above in this section. The coping capacity of the slum population is usually the lowest, increasing the vulnerability to climate change. It is also essential to note that10% of Goa's population lives in Mormugao and it has the highest population density in the state as well.

Table 12:Mormugao Statistics

Area smallest	109.13 sq. km	
Population	154561	
Population density	1416	
Population density highest in state		
Percentage of the state population	10.6	%
Literacy rate	85%	

Table 13: Distribution of slum population in Goa (Census 2011)

Distribution of Slum Population in Goa- 2011 Census

Area	No. of Slum Households	Slum Population	% to total slum population
Ponda (MCl)	258	981	3.74
Mormugao (MCl)	4974	23625	90.01
Margao (MCl)	265	1641	6.25
Total	5497	26247	100.00

Source: Registrar General and Census Commissioner, India.

Health impacts due to climate change can have more significant and serious impacts on young children especially those from the vulnerable group. Poor sanitation increases vulnerability to gastro-intestinal illnesses, with future rates of diarrheal diseases among children are expected to rise under many climate change scenarios (Cissé et al, 2018, WHO 2014).

Hence, the most vulnerable population in the state needing immediate attention is concluded to be a slum population of Mormugao, young children below the age of 10 years, women, and families whose livelihood depends on Khazan lands only.

Cultivation in the Khazan Lands

Plains running parallel to the coastline. These plains are flooded annually by brackish water from the Rivers and Creeks and hence, are fertile but saline. Most of these Khazan lands are used for the cultivation of salt-resistant species. Runoff collects in these fields (earlier these fields were also drained by tidal waters). The main crops grown in these fields are rice and vegetables. Most of the cultivation is done using manure and the use of fertilizers is limited. The soil itself is very fertile owing to backwaters and saline resistant varieties of rice are cultivated in Goa.

5.3.Prioritization of sectors for SAPCC

Based on the above assessment, the following sectors and regions in the state have been prioritized in the SAPCC:

5.4. Climate vulnerability and impacts due to diversion of Mhadei River

While in the observed climatology over 1901-2018, mean annual rainfall in the state has increased (Figure 18). However, it has not helped the water security scenario in the state as we find that moderate to light rainfall events that nourish ecosystems have declined, very heavy and exceptionally heavy rainfall events that cause devastation and chaos to life-forms and ecosystems, have increased in the state (Figure 20). Looking forward in future, as per dynamically downscaled regional climate projections from IITM, rainfall in Goa is likely to slightly decline or remain stable (Figure 23). Given that under future climate projection scenarios very heavy and exceptionally heavy rainfall events are likely to increase further (Figure 26), also as losses from evapotranspiration due to warmer climate are projected to increase - water security scenario in the state is likely deteriorate further under climate change scenarios.

Sr. No.	**Sector**
1	Transport
2	Power (Energy) & Renewable energy (GEDA)
3	Water
4	Forest sector
5	Agriculture and Allied (AVHS) sector
6	Fisheries sector
7	Environment & Coastal Management
8	Biodiversity & Wetlands
9	Solid Waste Management
10	Sewage Management
11	Tourism
12	Mining
13	Land use land cover
14	Human Health
15	Disaster management
16	Habitat
17	Infrastructure

6. Sectoral Mitigation Strategies

6.1. GHG Profile of the State

As per India's second Biennial update report, energy sector contributes 73.2% of India's total GHG emission, followed by agriculture, industrial processes and waste contributing to 16%, 7.8% and 3% respectively. GHG emissions in energy are predominated by the emissions from energy industries (60%), followed by manufacturing industries and construction (18%), and transportation (13%).

State of Goa does not produce power, it purchases power from NTPC power plants except for some renewable energy, based power plants like solar power plants. Thus, the direct GHG contribution of the state to national GHG inventory is not significant.

The major GHG emitting sectors in the state are transportation sector, agriculture, waste, construction and mining sector. While the power sector does not result in direct GHG emissions in the state, it does contribute to overall GHG inventory of the country. Hence, it is essential to view the energy sector from the perspective of demand side power consumption and generation of renewable energy to contribute towards countries GHG inventory.

On the other land use and land cover change has the potential to act as both a sink or an emitter depending upon the state level activities.

6.2. Sectoral GHG mitigation strategies

6.2.1. Transportation Sector

Road Transport: Transportation by road in the State is considered to be the dominant medium for both passenger and freight transport. Initiatives are being taken to provide a secure, integrated, proactive and pioneering transport system to reduce traffic congestion, road accidents, vehicle pollution, etc. in the State. About 14 lakh vehicles have been registered in Goa up till FY 18-19. On average, about 78,000 vehicles are being registered every year in the last five years resulting in an increase in vehicle population by approximately 7%.

Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Motor Vehicles registered	1009362	1083678	1158241	1238644	1324763	1399833[6]

About 70% percent of vehicles are registered in the category of two-wheelers followed by private cars and jeeps including taxis which form about 22.06 percent of the vehicle population. Goa's traffic profile is dominated by vehicles for tourism-related transport, personal transport, and interstate cargo as Goa's state highways provide an effective route for transportation

[6] Source: Goa Economy in Figures

between the southern and western states. 54144.10 MT of cargo traffic has been handled in the State in 2017-18[7].

In some parts of Goa, the demand for public transport is very high. To fulfil the demand the KADAMBA TRANSPORT CORPORATION LIMITED (KTCL) is operating a nonstop shuttle service on various routes like Panaji - Margao, Panaji - Vasco, Margao - Vasco, Panaji - Ponda, PanajiMapusa and Margao-Curchorem.[8]

Table 14: Vehicles by Category[9]

Sr. No.	**Type of Motor vehicle**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**
	1	**16**	**17**	**18**	**19**	**20**
	Transport					
1.	Motorcycle for hire	1399	1688	1788	1746	1266
2.	Goods vehicle	1466	1531	1591	1530	1456
3.	Taxis	1122	1067	813	1269	1192
4.	Buses+ Minibuses including KTC	969	299	279	385	259
5.	Autorickshaws	129	102	118	107	54
6.	Fire Tenders	NOT AVAILABLE				2
7.	Ambulance					1
	Total	**5085**	**4687**	**4589**	**5037**	**4230**
	Non-Transport					
1.	Motorcycles+ Scooters	50732	52711	53458	56926	49486
2.	Private cars+ Jeeps	15016	16767	16353	18267	17625
3.	Tractors & Others	144	141	158	168	124
4.	Government vehicles	13	10	5	5	2
	Total	**65905**	**69629**	**69974**	**75366**	**67237**
	Grand Total	**70990**	**74316**	**74563**	**80403**	**71467**

Water Transport: Goa has a network of Inland Waterways, navigable throughout the year. It has a widely spread network of inland waterways comprising of two main rivers Zuari and Mandovi and other small rivers such as Terekhol, Chapora, Mapusa, Sal, etc. [10] These rivers have sufficient draft for navigation and are used for transportation. They serve two types of transportation:

[7] Statistics is up to December 2017
[8] Source: Economic Survey 2017-18
[9] Source: https://www.goatransport.gov.in/Statistic
[10] Source: https://www.goa.gov.in/department/river-navigation/

- Transportation of passengers and vehicular traffic living in the islands and across the rivers not connected by roads and bridges
- The movement of heavy and bulky mineral ores from interior parts up to the Mormugao Harbour, which is the only major economic port of the State

The River Navigation Department (RND), is mainly engaged in the operation of ferry services in the inland waters of Goa. RND wishes to focus on public transport which is core to its service mission while identifying non-core activities such as fast ferry service across the important towns/cities for public, vehicles and good. Ferry service from Panaji to Vasco has been identified as one of the viable development options for the development of waterways.

River Navigation Department (RND) provides 24 hours ferry transport to the commuters at 20 ferry routes all over Goa with fleet of 39 ferry boats. Everyday about 2.5 lakhs commuters and 18000 vehicles use the ferry service. There is a potential to further utilize the inland water ways.

Initiatives and Schemes to support climate friendly development in transport sector:

Scheme 1: The Goa State Subsidy for replacement of old Passenger Buses Scheme, 2001

Objective: The scheme provides subsidy for replacement of buses older than 15 years with a view to curtail vehicular pollution and to provide an efficient, reliable and comfortable service to the users.

Scope of the Scheme: The scheme covers the owners of buses and mini buses of model older than 15 years covered by valid regular permit and which are in operation for a continuous period of past 3 years.

The scheme also provides for disbursement of subsidy for purchase of new vehicle on replacement of following types of vehicles:

Sr.	Age of the vehicle	Type of vehicle	Seating capacity	Amount of subsidy to be disbursed
1.	Between 10 to 15 years	Bus	49-seater and above	₹6.00 Lakhs
2.	Between 10 to 15 years	Minibus	39-seater and below	₹4.20 Lakhs

3.	Between 15 to 20 years	Bus	49-seater and above	₹3.90 Lakhs
4.	Between 15 to 20 years	Minibus	39-seater and below	₹3.30 Lakhs
5.	Above 20 up to 25 years	Bus	49-seater and above	₹3.30 Lakhs
6.	Above 20 up to 25 years	Minibus	39-seater and below	₹2.70 Lakhs
7.	Above 25 years	Bus	49-seater and above	₹2.70 Lakhs
8.	Above 25 years	Minibus	39-seater and below	₹2.10 Lakhs

Scheme 2: The Goa State Fuel Subsidy to Private Stage Carriage Operators Scheme, 2014

The objective of this scheme is to provide socio-economic support to entrepreneurs in the trade of operation of stage carriage on intra-state routes. The scheme covers the owners of private buses/minibuses operating on intra-state routes as "stage carriage" as well as those intending to enter the trade for the first time. The scheme provides for disbursement of fuel subsidy of ₹3/- (Rupees three only) per kilometre of operational distance.

Under the Goa State Fuel Subsidy to Private Stage Carriage Operators Scheme, 2014 fuel subsidy to 333 bus operators amounting to ₹ 791.72 lakh was disbursed till December 2017.

KTCL has also undertaken several initiatives which improve the efficiency of its fleet:

- Replacement of overage fleet for better cost control and increase in the load factor.
- Energy conservation measures such as Smoke control, Anti-pilferage device, Purchase of fuel-efficient engine and Modification of bus-body design

GOA ELECTRIC MOBILITY PROMOTION POLICY – 2020 is under finalization and the below given are important projections which are relevant to SAPCC.

This policy envisages to provide manufacturing incentives, demand incentives, upfront incentives, tax incentives and also non fiscal support in addition to innovation. Electric charging stations including solar-powered stations are planned.

Under the National Electric Mobility Mission Plan (NEMMP), Government of India has envisioned 6-7 million electric and Hybrid vehicles on Indian roads by 2020. Towards this goal, the Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) scheme has been launched by Department of Heavy Industries, Government of India. Its target is saving 120 million barrels of oil and 4 million tons of CO_2 as well as lowering of vehicular emissions

by 1.3 % by 2020. FAME India scheme has four focus areas–technology development, demand creation, pilot projects and charging infrastructures.

Based on the recent techno-economic developments in EV sector and the vision of Government of India, a need was felt by Government of Goa to formulate a policy for promotion of this sector in Goa. Building on indigenous strengths of tourism and IT industries, Government of Goa envisages to build Goa as a model State in EV.

Despite the unorganized nature of the transport sector, Goa stands on top in the country in terms of per capita vehicles with 625 vehicles for every 1,000 people in the state and is also ranked 15 in the world in terms of vehicle density. According to an estimation by Goa Automobile Dealers Association (GADA), on average, every Goan household has about 2 bikes and one car. With an urbanization rate of 62%, these numbers are only expected to grow. Hence, there is an eminent need to ensure growth of this sector does not further environmental degradation. Adoption of new energy vehicles (NEVs) would also be supported by utility growth in the state.

OBJECTIVES:

1. 30% of annual vehicles registered in Goa, starting from the year 2025, would be electric.
2. To convert 50% of all ferries to electric by 2025.
3. To create 10,000 direct and indirect jobs in the sector by 2025.
4. To encourage start-ups and investment in the field of electric mobility and associated sectors such as mobility as a service (MaaS), autonomous vehicles, data analytics and information technology.
5. To promote service units which would include Electric Vehicles and battery repair and maintenance stations.
6. To promote R&D, innovation and skill development within the EV sector.

Mitigation Measures: In addition to the above schemes, there is scope and need for the state to take measures to develop a low carbon transportation system for the state of Goa. The Mitigation Measures proposed to be implemented under the SAPCC by this sector are provided below.

Table 15: Mitigation Strategy for Transportation Sector

Sr. No	Intervention		Status	Responsible agency	Barriers and Gap in implementation	Intervention Type
	Intervention	**Type**				
1	Electric mobility policy should be developed by state	Mitigation	proposed	Transport department	Gap: e-charging stations State does not produce electricity	Policy
2	Provisions should be made for non-motorized transportation in urban areas to decongest and reduce GHG emissions	Mitigation	to be modified	Transport department		Activity
3	Development of a wholistic policy for low emission sustainable transport system	Mitigation	proposed	Transport department		Policy
4	The Goa State Subsidy for replacement of old Passenger Buses Scheme, 2001	Mitigation	under progress	Department of Transport		Scheme
5	Identify Alternate mode of fuel transportation in the mining area	Mitigation	proposed			Activity
6	Explore the possibility of using CNG instead of petrol and diesel	Mitigation	proposed	Department of Transport	Barrier- Availability of CNG	Scheme
7	Solar power vessels for inland water ways	Mitigation	proposed	RWN	Cost	Activity
8	Convert existing vessels to CNG vessels	Mitigation	proposed	RWN	Cost	Activity
9	Make adequate parking space for vehicles					
10	Provide interconnected public and non-motorized					

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type
	system for point to point connectivity				

Note 1 : The Concerned Department is expected to carry out GAP analysis and ascertain budgetary provisions and implications for the activities mentioned above and add more activities relevant to climate change within the period of at least three months.

Note 2 : **Approximate financial implications of transport sector expected to be met from climate change plan for ten years are approximately ₹ 75 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.**

6.2.2 Power Sector

Power today has become indispensable for all its users. Goa does not generate its own power and its current energy needs are met by purchasing power from the Central Sector Power Stations of the National Thermal Power Corporation (NTPC) as per the allocation made by the Central Government. Besides this, a small amount of 16 MW of power is generated by Naphtha based power plant operated by Reliance Energy Limited at Sancoale, Mormugoa. This plant supplies power predominantly to private industries and a small amount of power is sold to the state grid. Power is also bought from Saligao Solid Waste Treatment Plant for promoting the generation of renewable energy. **The Key agency in electricity sector in Goa is Goa State Electricity Department.** Electricity department is meeting its renewable power obligation (RPO) as framed by Joint Electric Regulatory Commission from time to time. **For the year 2020-21 Goa proposed to purchase 17% of its Power demand from renewable sources**.

Goa Energy Development Agency (GEDA) is responsible for the promotion and production of renewable energy in the state. Goa Solar policy was developed in 2017. Few significant initiatives proposed are given below.

Goa Energy Development Agency (GEDA)

a. Biogas from municipal solid waste, sewage and cow dung/ animal dung to electricity and compressed biogas.
b. Biomass to energy from aggregation of biomass from garden, tree cuttings, monsoon shrub cutting, coconut shells, leaves etc.
c. Centralized facility for Biomass to ethanol conversion project
d. Wave energy/ tidal energy Project
e. Replacement of electricity based pumps of farmer to solar energy driven pumps.

f. Introduction of CBG buses in local state transport.

The Electricity Department of Goa provides both low tension as well as high tension supply to consumers, besides street lights and high masts in public areas. For its future needs, the Power Grid Corporation of India has commissioned a 400 KV transmission system that will enable Goa to draw power to the extent of 500 MW.

Goa has achieved 100% electrification. Goa's per capita power consumption is about 1100 kWh per year. The share of the industrial sector in Goa's power pie is much larger. In 2017-18 about 60% of the power was consumed for industrial purposes whereas 26% was consumed for domestic and 11% for commercial purposes.

Table 16: Energy Demand in Goa[11]

Year	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**
Energy consumed for Domestic purposes (MKWh)	912.00	730	1010	880.59	924.14
Energy consumed for Commercial purposes (MKWh)	224.00	409	394	368.45	386.03
Energy consumed for Industrial purposes (MKWh)	1411.00	1839	1796	1986.92	2053.75
Energy consumed for Irrigation purposes (MKWh)	21.00	31	18	29.94	29.94
Energy consumed for other purposes (MKWh)	466.00	105	50	86.26	100.86
Total power consumed (MkWh)	3034	3114	3268	3352.16	3494.72

Table 17a: Mitigation Strategies for Energy Sector- Supply Side Interventions

[11] Source: Goa at a Glance

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget (INR crore)	Source of Finance
1	PPA has been executed with SECI for purchase of 25MW of solar power for a period of 25 years from 2015 onwards	Completed	Electricity Department		Others	*	Existing Department Budget
2	Three Power sale agreement (PSA) of 50 MW wind each have been executed with SECI to meet the additional power requirement	Completed	Electricity Department		Others	*	Existing Department Budget
3	50MW of wind power from above PSA is available from May 2019 other two still awaited	Under progress	Electricity Department		Others	*	Existing Department Budget
4	Power of about 2MkWh is also bought form Saligao Solid Waste Treatment Plant for promoting generation of renewable energy	Completed	Electricity Department		Others	*	Existing Department Budget
5	300 MW of solar to be set up by 2030	proposed	GEDA	Creating enough market-based employment	Activity	Rs 47000/ Kw	Own budget and Central Government Contribution
6	25 MW of renewable energy to be set up by 2030	proposed	GEDA	Creating enough market-based employment	Activity	*	Own budget and Central Government Contribution
7	Electrification in rural set up and in hinterlands to be taken up through off grid non-conventional sources like solar rooftop, biogas, kitchen waste etc.	Proposed	GEDA		Policy/Scheme	*	Existing Department budget
8	Goa Solar policy 2017 (amended in February 2019)	completed	Department of Non-Conventional Energy Sources		Policy	*	

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget (INR crore)	Source of Finance
9	Goa Wind Policy	proposed	Department of Non-Conventional Energy Sources		Policy	*	
10	Goa must explore the possibility of tidal energy and further enhance mini-hydro potential	proposed	Department of Non-Conventional Energy Sources		Policy	*	
	Note – The financial implications expected for GEDA under climate change is broadly ₹ 25 crores. The detailed plan for expenditure and gap analysis will be prepared within 6 months by the department.						

Table 18b: Mitigation Strategies for Energy Sector- Demand Side Interventions

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget (INR crore)	Source of Finance
1	Demand Side Management (DSM) measure - All types of conventional Street light fixtures (i.e. 1.77 lakh) are being replaced by high quality efficient smart LED light fixtures under the Street Lighting National Programme (SLNP) of Government of India through Energy Efficiency Services Ltd (EESL), a joint venture of PSUs of Ministry of Power, Government of India on ESCO model.	completed	Electricity Department		Others	45 crores	State Government Funds (40%) & Central Govt requested for balance

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget (INR crore)	Source of Finance
2	Under the Deendayal Upadhyaya Grameen Joyti Yojana (DDUGJY) installation of digital meter	Completed	Electricity Department	Already 166000 have been installed but now smart is intended	Scheme	20crores	Own budget and Central Government Contribution
3	Jyotirmay scheme - distribution of 3 LED bulbs of 9W each to domestic households. 8.2 lakh bulbs have been distributed under the scheme	Completed	Electricity Department		Scheme	*	State Government funds
4	Goa has executed a Bipartite MoU with the Ministry of Power, Government of India and joined the "UDAY" scheme. - AT & C losses controlled to 12% improving feeder efficiency. AMR remote metering for HT consumers, substation feeders and Distribution transformers installed. GIS for Asset mapping and SAP system for billing implemented.	under progress	Electricity Department		Scheme	*	Existing department budget
5	Mandating periodic Energy audit to improve energy consumption and operational efficiency of all government establishments	proposed			Others	*	Existing Department Budget
6	Industrial energy efficiency should be promoted through BEE's programs	proposed	State Designated Agency for Electricity Department (SDA)		Others	*	To be funded by BEE and industries
7	Incentivization of energy efficiency for commercial and domestic users	proposed	State Designated Agency for Electricity Department (SDA)	Consumer awareness and willingness	Scheme	*	To be funded by BEE

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget (INR crore)	Source of Finance
8	Programs to develop awareness on saving of energy	proposed	State Designated Agency for Electricity Department (SDA)		Others	*	To be funded by BEE
9	Training and skill development for renewable energy implementation, maintenance and energy auditors etc.	proposed	GEDA	Creating enough market-based employment	Awareness raising and capacity building	*	Own budget and Central Government Contribution

(* Detailed cost estimates and gap analysis will be carried out relevant to climate change related activities within six months at departmental level and financial implications of about ₹50 crores will be also detailed out)

Proposed initiatives & Finance requirements for

- **Smart metering (918 crores required)**
- **Underground cabling (HT and ST) (4500 crores required)**
- **GIS substations for forested areas 22 substations (Rs 484 crores)**
- **Underground networking of LTE in forested areas 500 kms target in ten years (Rs 550 crores)**

Approximate financial implications of transport sector expected to be met from climate change plan for ten years are approximately ₹ 75 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.

6.2.3 Agriculture and Allied Sector

Agriculture sectors contribute to climate change through the use of irrigation equipment and other machinery used. Water flooding based irrigation practices, burning of agricultural waste or uncontrolled decay of waste also contributes to GHG emission. To contain the emissions from this sector below mentioned intervention and strategies are proposed.

Table 19: Mitigation Strategies for Agriculture Sector

Sr. No	Intervention		Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance
	Intervention	**Type**					**INR crore**	
1	Focus initiatives to increase vermi-composting at community level	Mitigation	proposed	Department of Agriculture		Scheme	*	Others
2	Incentivize replacement of agricultural pumps with energy efficiency pumps and solar pumps	Mitigation	proposed	Department of Agriculture and department of energy		Scheme	*	
3	Sensitize farmers on optimal utilization of water to reduce pump usage and reduce water wastage	Cross Cutting	proposed	Department of Agriculture		Awareness raising and capacity building	*	Existing Department Budget
4	Incentivize optimal utilization of water pumps (this	Cross Cutting	proposed	Department of Agriculture		Scheme	*	Own budget and Central Government Contribution

Sr. No	Intervention		Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance
	includes installation at appropriate RM Pand head)							
5	Promoting organic manure	Cross Cutting	under progress	Department of Agriculture		Activity	*	Existing Department Budget
6	Optimal utilization of fertilizers and pesticides	Mitigation	under progress	Department of Agriculture		Activity	*	Existing Department Budget
7	Provide assistance in utilization of cattle and animal waste as manure and for biogas generation	Mitigation	proposed	Department of Agriculture		Activity	*	Own budget and Central Government Contribution
8	Promoting Biomass residue from agriculture to be used for power generation where it does not have an	Mitigation	proposed	Department of Agriculture	Aggregation of farmers and setting up of power plant	Activity	*	Others

Sr. No	Intervention		Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance
	alternate use							

(* <u>Detailed cost estimates and gap analysis will be carried out relevant to climate change related activities within six months at departmental level)</u>

<u>Note -</u> Proposed ball park estimates for next ten years for Agricultural sector arrived at through broader consultation is ₹ 50 crores. Details will be worked out by the department within 6 months towards this.

6.2.4 Waste Management Sector

The State of Goa has been proactively working on the issue of solid waste management. To maintain a clean and litter-free environment and to ensure proper Solid Waste Management across the State, various initiatives have been undertaken by the State as follows:

The first major initiative is the collection of all the plastic waste across the National Highways.

Highway waste collected by GWMC

HIGHWAY COLLECTION				
Month	Dry	Wet	Tree	**Total (Tonnes)**
Jan-20	34.62	17.38	1.51	**53.51**
Feb-20	41.47	36.93	1.59	**79.99**
Mar-20	84.69	76.06	0.3	**161.05**
Apr-20	59.86	0	1.28	**61.14**
May-20	67.43	0	0	**67.43**
Total				**423.12**

The second major initiative is setting up Solid Waste Treatment Facility one each, in North Goa and South Goa. The first such state-of-art facility has been already set up in

Saligao/Calangute in Bardez Taluka in 2016 and the second one, at Cacora, which is likely to be commissioned during the end of this year i.e. 2018.

GWMC has signed an agreement with e-waste PRO Karo Sambhav for collection of all types of e-waste generated. Further, the e-waste condemnation policy for the State is being amended to mandate condemnation only against disposal and not buy-back, which reduces the flow of government e-waste to the informal sector in the State.

Department is in the process of setting up of Common Biomedical Waste Treatment Plant at Kundaim Industrial Estate. The Goa Waste Management Corporation formed by the State Government has been entrusted to look after the management of all types of wastes, collection of dry non-biodegradable waste from Village Panchayats, Municipalities, State & Central Government Institutions, Industrial Estates, and other organizations in the State and its safe disposal.

The collection of segregated waste is the first step. Followed by composting of bio-waste.

A state-of-the-art facility using the latest technology for solid waste management has been commissioned and made operational at Calangute by the Government of Goa, to treat and dispose of the solid waste from coastal villages in North Goa. This modern facility is based on the Mechanical Biological Treatment (MBT) process with proper segregation, recycling, and bio-methanation technology. The functioning of the plant and selection of technology has been made to address all issues of odour, unsightly garbage mounds and leachate generation. Electricity produced in-house from the organic fraction of the waste will be used to power the entire plant operation. The state government is proposing to establish similar SWM management facility at Bainguinim in North Goa and Cacora in South Goa in their action plan for SWM for Goa[12]. The solid waste management cell of the DST is collecting segregated nonbiodegradable waste from the village panchayats and bailing it. Details of other SWM facilities planned by the state is provided as annexure I.

State of Art Waste Management Facility at Saligao

The integrated Solid Waste Management Facility (SWMF) at Saligao is a state of art facility set up in 2016 which is scientifically managing waste as per the SWM rules 2016 and is successfully catering to 25 local bodies along the coastal belt of North Goa, additionally, the plant also caters tobeach cleaning waste and highway cleaning waste. The plant was designed for 100 Tonnes Per Day (TPD) capacity which has been enhanced to 150TPD. The facility was built on existing 20-year-old 73,198tonnes waste dump after remediation of the same.

[12] Carrying Capacity of Beaches of Goa for Providing Shacks & Other Temporary Seasonal Structures in Private Areas

- Facility Treated total of **186008.3Tonnes** Municipal Solid Waste from May 2016 to May-2020.
- **63399Tonnes** of RDF generated which is being disposed for coprocessing to cement factory from the facility.

277925KW (277 MegaWatt) power generated from the facility from Aug 2016 to May-2020.

1) Remediation of existing legacy dumps in Goa

The works contemplated under this contract consist of "Remediation, providing monsoon cover wherever required and safe disposal of the separated fractions from existing old Municipal Solid Waste (MSW) at various locations (11 identified) in Goa" shall be applicable to various MSW dumpsites within the state of Goa. GWMC accordingly floated tender for remediation and issued work order to 3 bidders to carry out remediation of 11 identified legacy waste sites in the State of Goa.

Other than the 11 sites, till date the State has remediated approximately 1,23,000 tonnes of waste from legacy dumps at Saligao, Cacora and Aradi. Besides till date among the 11 identified sites, waste remediation has been commenced at following sites

- Sada (Mormugao Municipal Council) ~1,15,000 m3 waste is remediated
- Sonsodo (Margao Municipal Council) ~1,05000 m3 waste is remediated
- Assagao (Mapusa Municipal Council) ~~32,000 m3 waste is remediated
- Campal Parade Ground (Corporation of the City of Panaji) ~ 6,800 m3waste is remediated

Few important items in Goa's waste management strategy should include:

1. Waste minimization in the tourism sector by providing alternate and bio-degradable options for tourist

2. Incentivising disposal of plastic waste by providing ride coupons or other tourist coupons in exchange for disposal or deposition of plastic waste at designated areas

Approximate financial implications of transport sector expected to be met from climate change plan for ten years are approximately ₹ 25 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.

7. Chapter 7: Adaptation Strategies

7.1. Water

Water sources

The State receives a copious annual rainfall of about 2500 to 5000 mm from the southwest monsoon. Four of the seven rivers in the state, namely, Mandovi, Zuari, Galijibag, and Talpona occupy about 77.70% of the State's geographical area. Mandovi and Zuari are the two largest rivers. 'Dynamic Ground Water Resource of India, (March 2013 - June 2017) has estimated the net groundwater availability in the State as 14625 ham[13]. The stage of groundwater development is 37%, which falls in the safe category of groundwater exploitation.

Though Goa is situated in high precipitation zones, it has one of the lowest per capita freshwater availability. The draft state water policy 2015 presents various challenges faced by the state in the utilization of the water resources. The rivers are prone to tidal variations up to 40 km inland and seasonal variation in the availability of water.

In the mining zones, water scarcity has been increasing due to the withdrawal of groundwater and the non-replenishment of wells.

Current status of water and associated facilities

The Water Supply in the State of Goa is catered through Regional Water Supply Schemes and Spot Sources. The Public Works Department is looking after the Water Supply Sector including Operation and Maintenance in the entire State of Goa in both Rural and Urban Areas.

The state has a total water treatment capacity of 601 MLD. Rural areas are supplied with water at the rate of 82LPCD and urban areas with 143LPCD. The state intends to achieve 24x7 water supply scenario with 100 LPCD supply in rural areas, and 150 LPCD in urban areas. By 2025, state intends to have installed capacity for water at 711 MLD.

All the Water Treatment Plants are equipped with Water Testing Laboratories for regular water testing. The quality of the drinking water is regularly checked to maintain all service standards and quality is maintained at all levels. The details of the Present Water Supply Schemes are:

Total Installed Capacity is 601.43 MLD

Regional Water Supply Schemes	-	580.22 MLD
Additional Schemes (Pressure Filter)	-	14.42 MLD
Additional Spot Sources	-	6.79 MLD

Details of Water supply schemes are provided as annexure II.The majority of the population depends on traditional septic tank and soak pit system for the disposal of wastewater. As of FY 2016-17, urban areas in the state generate 253 MLD of wastewater out of which 36% is treated through the sewerage treatment plant. In the near future state intends to improve the sewerage facilities in all uncovered areas. It is also proposed that sewerage facilities are provided to the rest of the state in a phased manner in order to achieve total sanitation and zero discharge of

[13] 1 cubic meter is equal to 0.0001-hectare meter (ham)

wastewater into the environment. IN FY17-18, 9% of the government's non-tax revenue came from water supply i.e. INR 126 crore.

The state has assessed its total water requirement by 2051 to be 8030mcm. Total water resources that can be conserved have been identified to be worth 1585mcm. In 2015, Goa's Ground Water Policy was also prepared with the aim to develop & regulate groundwater on a sustainable basis and manage it in a professional manner to prevent its pollution and degradation.

To support the water policy, groundwater policy and strengthen the water and related systems in the state following are the key items undertaken by the state:

Schemes and Initiatives

- 'Nital Goem Nital Baim' has been introduced to help promote the conjunctive use of water and also maintain the groundwater structure in the State.
- Master plans have been prepared for optimal utilization of the water resources of the four river basins of the State
- Scheme for post monsoon water harvesting for groundwater recharge through the construction of a series of bandharas across rivers and nallahs in the sweet water zones.

Projects and Activities

- Replacement of old AC pipeline by 300mm dia D.I water supply pipeline from Zrowado Chapel up to Navelim church in Navelim Constituency at a cost of ` 400.00 lakh
- Providing & laying of conveying main & distribution main and Construction of 800 m3 GLR at Bastora at a cost of ` 156.81 lakh.
- Replacement of old 150mm AC pipeline from 800m3 GLR at Desai Nagar to Upper Harvalem in Sankhali Constituency at a cost of ` 216.99 lakh
- The National Hydrology Project provides additional financial support and also offers an excellent opportunity to introduce new technologies into water resource sector planning & management.
- Online services like Registration of wells and tankers under the Groundwater Regulation Act, 2002
- Act to charge rates for drawl and transportation of groundwater under different uses and register all the drilling companies who drill borewells in the State.

Impact of climate change on water resources in the state:

1. **Seawater intrusion or saltwater ingress** will increase the salinity of groundwater near the coastal areas rendering it unusable. With sea-level rise due to climate change and indiscriminate use of groundwater the problem of saltwater intrusion will be exasperated.

2. **Increased back flow of water into rivers and drainage channels.** This is an indirect impact. As an example: The formation of beaches on Querem and St. Inez is taking place. This is indicative of the sand deposition trends along the Panaji coastline. The formation of this beach has led to blockage of water flow of the St. Inez creek into the Mandovi River and hence, has increased backflows[14]. In the case of climate phenomena like high-intensity short-duration rainfall, the impact could be an increased impact of floods due to clogged drainage channels.
3. **Increased pollution of water bodies and flooding:** Due to the high-water table the soaking capacity of the soil is generally poor in Goa. With increased precipitation events the runoff will increase and inadequate sewerage network and sanitation facilities have the potential to mix run off with sewerage and other contaminants leading to pollution of water bodies like ponds, lakes, tanks, etc.
4. **Increased risk to water-related structures and infrastructure:** Directly and indirectly climate change and other non-climatic stressors increase the risk of failure of infrastructure. For example, increased peak rainfall incidents in Goa where the water table is high and the soil is saturated can further elevate the changes of the landslide, mudslide, etc. Such sliding events have the potential to impact the water supply pipeline, sewerage network, etc. Some parts of Goa have in the past years experienced the impact of such events.

Impact on Mandovi River due to climate change

In Mandovi River Saline water intrudes up to 46 Kms. in the river Mandovi up to Ganjem. If the sea level increases as apprehended on account of global warming, the saline water will intrude even further into the river. When the sea levels rise rapidly, as they have been doing, even a small increase can have devastating effects on coastal habitats. As seawater reaches further inland, it can cause destructive erosion, flooding of wetlands, inundation of Khazan lands, contamination of aquifers and agricultural soils, and loss of habitat for fish, birds and plants. Ground water aquifers will also get impacted. An area of 509 sq.kms at the lowermost end of the Mandovi basin, i.e. about 32% of the basin area in Goa is subject to tidal effects and the water resources in this area are not fit for harnessing for any consumptive uses. Increased salinity due to sea level rise resulting from global warming is bound to enlarge the tidal zone of the basin and thereby progressively reduce the available utilizable fresh water resources.

[14] Urban Vulnerability Assessment Report, Panaji City, India, GIZ, March 2013

The climate change scenario is also likely to alter the rainfall and cause water shortage. It is likely to have a general overall reduction in the quantity of available run off in rivers originating in Western Ghats including Mandovi.

Synergy with National Water Mission and SDG

The adaptation measures outlined below have been developed to align with the National Water Mission (NWM) and SDG6.

NWM's main objective is "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management". The five identified goals of the Mission are: (a) developing comprehensive water data base in public domain and assessment of impact of climate change on water resource; (b) promotion of citizen and state action for water conservation, augmentation and preservation; (c) focused attention to vulnerable areas including over-exploited areas; (d) increasing water use efficiency by 20%, and (e) promotion of basin level integrated water resources management (IWRM).

The Sustainable development goal (SDG) number 6 focuses on clean water and sanitation. Its goal is to *Ensure availability and sustainable management of water and sanitation for all*.

The targets for SDG 6 are:

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water

harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

Hence, the adaptation measures on water for the state of Goa would focus on:

1. **Adaptation of water related infrastructure**

Several activities to upgrade, augment and supplement water supply and sewage treatment are planned in Goa. These proposed activities will increase adaptive capacity. However, Climate vulnerability of infrastructure proposed, infrastructure site and the infrastructure should also be assessed. For example, the probability of water sump or treatment plant getting submerged or flooded due to changing climatic phenomena will cause financial vulnerability and availability of critical resources during disasters as well will be compromised.

To avoid such a scenario, it is proposed that:

- **Implementable guideline for climate-proofing of water-related** infrastructure projects is developed for all types of water projects. These guidelines must be taken into account at the time of development of project DPRs. Examples of water-related projects where these may apply are water supply, sewerage network, wastewater treatment structures, etc.

- **Climate proofing existing key water supply and sewerage management infrastructure** lying in critical zones like low lying areas. Climate risk and vulnerability assessment of such infrastructure, prioritization and development of remedial action plan.

2. **Development of infrastructure to reduce impact on water availability and enhance water security**

Safeguarding groundwater against salinity and pollution is essential for water security. To achieve this:

a. There is a need to develop an integrated salinity control mechanism in coastal areas of Goa which would include measures to reduce the exploitation of groundwater.
b. The majority of the population is still dependent on traditional septic tank and soak pit system for the disposal of wastewater. Appropriate fecal sludge management or alternate management strategies to be developed and implemented.
c. Health hazards such as contamination of groundwater or drinking water due to the lack of adequate soaking capacity of the soil, letting of the wastewater in open drains is growing due to urbanization. It is proposed to cover all the major towns with sewerage network using appropriate technology, to take the goal of total sanitation and clean environment in urban areas. Provide sewerage network in all low-lying unsewered areas followed by extension of the network to all unsewered areas.

d. It is necessary to enforce various measures to make the residents avail sewerage connections in serviced areas.

3. Developing systems for appropriate planning of water to ensure water supply to all

- Draft water policy should be finalized after including climate resilience aspects.

  There is a need for a system of suitable water pricing to deal with increasing water scarcity in the future due to the adverse effects of climate change. It is also essential to include recycling and reuse component in the water policy.

- Treated wastewater can provide additional water resources to water-stressed regions and help in meeting the water needs of growing India. Therefore, the state needs to invest in wastewater treatment capacity keeping this long-term vision in mind and plan for practical options for the introduction of recycle and reuse potential in the state by 2030. **A complete assessment of existing recycling and reuse potential for treated wastewater and the enablers needed for future capacities to be developed is missing in the policy.**

- Undertake a pilot on wastewater recycling and reuse before scaling it.

- Carry out a water audit to identify the potential for reducing water loss in the current water supply system

- Modernizing and expanding instrumentation and measurement techniques also enhance the ability to reduce water loss. Systematic investment in critical areas.

4. Maintenance of water resources to avoid flooding and to keep related infrastructure functional during peak events and disasters

Major rivers carry away surge water and help in reducing surge velocity to flooding, hence nearness to a major river decreases vulnerability while minor rivers can have the opposite effect likely because of their low water carrying capacity. It is essential to maintain the carrying capacity of rivers by desilting. Due to climate change, it is essential to review and revisit the existing maintenance plan for drains, sewerage networks as well as key water bodies like rivers and lakes.

- Revisit the maintenance plan of water bodies and conduct desilting accordingly
- Revisit the infrastructure maintenance plan and develop a climate-resilient infrastructure maintenance plan and implement the same

5. Knowledge management and capacity building (Forecasting and data base building)

Interdepartmental interaction: The different departments of the state government, whose work is related to water and climate change should have a common forum that should meet at frequent intervals to take an integral view of knowledge base and policy options. For this

purpose, the Department of Water Resources should have an effective cell headed by a Chief Engineer level officer. The climate secretariat shall be a part of this activity.

- Where feasible GIS based mapping of the sewer drains for better tracking and management
- Flood forecasting should be envisaged using real-time data acquisition systems and linked to forecasting models. Real-time Data acquisition systems should be provided to make flood level data available to concerned officials.
- The impact of climate change should be analyzed at sub-basin level such as Zuari sub-basin,
- High priority should be assigned to strengthening and creating adequate facilities for studies and research on hydrological, hydro-metrological and geomorphologic aspects related to climate change within the Department of Water Resources, WALMI, Universities, and other institutions

6. Awareness Raising

There is a need to take up massive programs of awareness generation among people at all levels about the adverse effects of climate change and the need to optimize water usage and conserve water.

Table 20:Adaptation Measures for Water Sector

Sr No	Intervention	Status	Responsible agency	Barriers & Gap in Implementation	Intervention Type	Budget (INR crore)	Source of Finance	Timeframe
1	Develop Implementable guideline for climate proofing of new water related infrastructure projects	proposed	Climate Secretariat	Gap: Exact information on climatic variables may not be available	Others	0.15	Own budget and Central Government Contribution	6 months
2	Implementation of guideline by including it in project planning and DPR stage	proposed	Water Resource Department, Municipal Administration		Policy	-	Existing Department Budget	1 year

Sr No	Intervention	Status	Responsible agency	Barriers & Gap in Implementation	Intervention Type	Budget (INR crore)	Source of Finance	Timeframe
3	Climate risk and vulnerability assessment of such infrastructure, prioritization and development of remedial action plan.	proposed	Climate Secretariat	Gap: Exact information on climatic variables may not be available	Others	0.2	Own budget and Central Government Contribution	6 months
4	Climate proofing existing key water supply and sewerage management infrastructure	proposed	Water Resource Department, Municipal Administration		Activity	Unknown		2 years
5	develop and implement an integrated salinity control program	to be modified	Multi department Ground water department, Municipal Administration etc		Others		Own budget and Central Government Contribution	3 years
6	faecal sludge management	proposed	Sanitation department		Activity	-	Own budget and Central Government	3 years

Sr No	Intervention	Status	Responsible agency	Barriers & Gap in Implementation	Intervention Type	Budget (INR crore)	Source of Finance	Timeframe
							Contribution	
7	to cover all the major towns with sewerage network	under progress			Activity	-	Own budget and Central Government Contribution	
8	Provide sewerage network in all low-lying unsewered area followed by extension of network to all unsewered areas.	under progress			Activity		Own budget and Central Government Contribution	1-5 years
9	Development of measures to make it mandatory to avail sewerage service	under progress			Activity		Existing Department Budget	1-5 years
10	Draft water policy should be finalized after including climate resilience aspects.	to be modified		Gap_ existing water policy does not include important climate change aspects	Policy	0.1	Existing Department Budget	6 months

Sr No	Intervention	Status	Responsible agency	Barriers & Gap in Implementation	Intervention Type	Budget (INR crore)	Source of Finance	Timeframe
11	A complete assessment of existing recycling and reuse potential for treated waste water and the enablers needed for future capacities to be developed is missing in the policy.	proposed			Policy	0.2	Own budget and Central Government Contribution	6 months
12	Undertake a pilot on wastewater recycling and reuse before scaling it.	proposed			Activity	15-20	NAFCC	3 years
13	Carry out water audit to identify the potential for reducing water loss in current water supply system	proposed			Activity	0.25	Existing Department Budget	1 year and then every three years
14	Modernizing and expanding instrumentation and measurement techniques also enhances the ability to reduce water loss	under progress			Activity	*	Existing Department Budget	continuous
15	Revisit the maintenance	proposed			Activity	*	Existing Depar	1 year

Sr No	Intervention	Status	Responsible agency	Barriers & Gap in Implementation	Intervention Type	Budget (INR crore)	Source of Finance	Time frame
	plan of water bodies						tment Budget	
16	Implement revised maintenance plan	to be modified			Activity	*	Existing Department Budget	1 year 6 months
17	Revisit infrastructure maintenance plan and develop a climate resilient infrastructure maintenance plan	proposed			Activity	*	Existing Department Budget	1 year
18	Implement of the plan	to be modified			Activity	*	Existing Department Budget	1 year 6 months
19	GIS based mapping of the sewer drains	under progress			Activity	*	Existing Department Budget	
20	Flood forecasting should be envisaged using real time data acquisition systems and linked to	proposed			Activity	*	Multilateral agency	2 years

Sr No	Intervention	Status	Responsible agency	Barriers & Gap in Implementation	Intervention Type	Budget (INR crore)	Source of Finance	Time frame
	forecasting models							
21	The impact of climate change should be analysed at sub-basin level such as Zuari sub-basin,	proposed			Activity	*	Others	5 years
22	massive programmes of awareness generation on water conservation	under progress			Activity	*	Own budget and Central Government Contribution	continuous
23	Reducing the NRM below 25%	proposed				*	Departments own budget	5 years by 2025

(* Detailed cost estimates and gap analysis will be carried out relevant to climate change related activities within six months at departmental level and in few cases these costs are not to be accrued to climate change)

Proposed ball park estimates for next ten years for energy sector arrived at through broader consultation is about ₹ 50 crores. The detailed financial breakup and gap analysis will be prepared and submitted by the department within six months.

However separate fund demand will be submitted within six months for climate related intervention after gap analysis.

7.2. Tourism

With a 105 km long coastline, Goa is a well-known tourist destination, primarily for coastal tourism. Four coastal taluks of Bardex, Tiswadi, Mormugao, and Salcete receive a maximum number of tourists. The annual tourist population in these taluks significantly exceeds the local population. Tourism in the rest of the taluks is minimal.

International tourists, mostly from Europe, arrive in Goa in winter whilst the summer and monsoon seasons see a large number of Indian tourists totalling to about 5,00,000 per annum. It is estimated that the total number of tourists visiting Goa has become nearly equal to the population of Goa.

Tourism is thus, one of the key important activities in Goa contributing to more than one-fourth of the state GDP and one of the largest employments providing industry in the state.

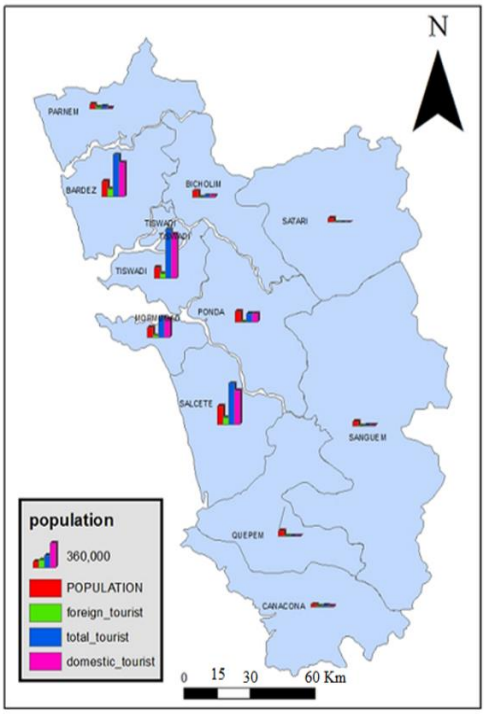

Figure 31: Annual Tourist footfall by Taluk

Due to the development of the tourism state has experienced a significant shift in employment activities from traditional fishing and agriculture towards tourism-related employment like water sports, beach shacks, etc. The pressure on infrastructural facilities in the State has also increased significantly due to tourism. While tourism generates revenue for Goa, it is highly dependent on natural resources.

Resource and impact of tourism:

Tourism activities have created an enhanced demand for water in the above-mentioned taluks. Groundwater exploitation has increased as a result of the same. On the other hand, in the absence of 100% coverage with sewerage network and sewerage treatment facility, groundwater and Marine pollution and eutrophication in the coastal waters are observed.

In India, Joevivek et al (2013) noted that sand dunes were destroyed for tourism development and coastal areas with high population density were causing erosion and decreasing the width of beaches. Goa's sand dunes and coasts are also under pressure and experience disturbance due to tourism-related activities.

Ecological disturbances, traffic congestion, and impact on air quality due to heavy traffic movement are some of the other impacts of tourism experienced by Goa.

Table 11: Sand Dunes along Goa coast within 200m in CRZ Area

Taluk	Panchayat	Area of Sand Dunes within 200m (in Sqm)
Bardez	Anjuna-Caisua	4183
	Calangute	46009
	Candolim	87949
Canacona	Poinguinim	559886
Salcete	Betalbatim	208409
	Colva	196776
	Cana-Benaulim	123149
	Varca	363438
	Cavelosim	613175
Mormugao	Cansaulim, Arossim, Culim	86217
	Pale-Valsao	31727
Total Sand dune area within 200 m		2320918

[1]http://des.nh.gov/organization/commissioner/pip/factsheets/cp/documents/cp-02.pdf extracted on 2 December 2016

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Regional plan of Goa up till 2021 ha been prepared. According to which Tourism Master Plan should be prepared keeping in mind the potential of the tourism sector and its sustainability and proposals of the tourism master plan including infrastructure shall conform to the eco-tourism policy. The eco-tourism policy promotes hinterland tourism. The state has taken several measures to provide adequate infrastructure for tourism and mandated large hotels to provide solar panels and treat the sewerage before discharge etc.

The carrying capacity of Goa's beaches has also been assessed to provide structured planning.

Impact of climate change

Climate change will impact tourism activities and any infrastructural and system deficiencies will only increase the impact.

1. Warmers temperatures as indicated earlier can cause heat stress leading to the altered tourist season, tourist time at the beach, etc.
2. Increase in sea temperature and acidity level can impact the ecosystem and reduce the attractiveness of sea for tourists engaging in certain water sports/activities like snorkelling or diving
3. Sea level rise will lead to loss of beach, coastal erosion and impact the tourist infrastructure.
4. Increase in high-intensity rainfall events could cause flooding and damage to tourist spots and tourist infrastructure like hotels
5. Changes in the length of and quality could have considerable implications for competitive relationships between destinations and therefore the profitability of tourism enterprises. Studies indicate that a shift of attractive climatic conditions for tourism towards higher latitudes and altitudes is very likely.
6. Changes in water availability, biodiversity loss, reduced landscape aesthetic, altered agricultural production (e.g., food and wine tourism), increased natural hazards, coastal

[15] Carrying Capacity of Beaches of Goa for Providing Shacks & Other Temporary Seasonal Structures in Private Areas http://www.dstegoa.gov.in/Beach%20Carrying%20Capacity%20Report.pdf

erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases will all impact tourism to varying degrees.

Adaptation Strategies for Tourism

Table 21: Adaptation Strategies for Tourism Sector

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance
1	Promoting community based agro tourism	proposed	Agriculture department and Tourism Department		Awareness raising and capacity building	*	
2	Inland tourism development in a climate friendly manner	proposed	Tourism department		Activity		
3	Tourism infrastructure climate vulnerability assessment	proposed	Tourism department	Barrier: Few precedence's and established practices	Activity		
4	Climate proofing and disaster management for critical tourism infrastructure	proposed	Tourism department	Barrier: Few precedence's and established practices	Activity		
5	Develop design standards for new tourist infrastructure and provide guidance for modification of existing vulnerable infrastructure	proposed	Multi-department	Barrier: Few precedence's and established practices	Policy		

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance
6	Enhance/modify and restructure the insurance for off-coast or water related tourism activities and infrastructure like boats and ships which are vulnerable to climate change	to be modified	Multi-department	Barrier: Few precedence's and established practices	Scheme		
7	Incentivize use of eco-friendly, recycle/reuse in the tourism sector by facility providers	to be modified	Multi-department	Barrier: Few precedence's and established practices	Scheme		
8	Single use plastic to be banned with credible alternates in tourism activity	proposed	Multi-department	Barrier: Credible alternatives, monitoring mechanism, incentives and tourist awareness,	Others		
9	Provide extensive infrastructure and encourage use of non-motorized transport by tourist - Develop a climate friendly	to be modified	Multi-department	Barriers: Inadequate wholistic infrastructure and marketing to promote the same	Scheme		

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance
	tourist mobility plan						
10	Green Skill and capacity development amongst the tourist service providers	proposed		Barrier: Willingness and local business models	Awareness raising and capacity building		
11	Environmental Clearance for large tourism projects/hotels in Goa could include climate mitigation and adaptation plan and climate disaster preparedness plan	proposed	SPCB/ any other local clearance body	Gap: No existing standard or precedence	Policy		
12	RE-consider the coastal development plan or zone for new construction based on the climate predications on sea level rise, flooding and erosion	proposed			Policy		
13	Reducing hotspot vulnerability						

Approximate financial implications of tourism sector expected to be met from climate change plan for ten years are approximately ₹ 5 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months. The detailed mechanism for green cess will also be submitted.

7.3. **Mining**

Mining in Goa is primarily focused on the sand and iron ore. The iron ore mining belt of Goa is mostly concentrated in four talukas namely, Bicholim of North Gia district and Salcete, Sanguem and Quepem of South Goa district. The mining belt of Goa is divided into three regions based on the concentration of the iron ore, namely, Northern, Central, and Southern Zone. Usgao River is the dividing line for the northern and central zone and Sanguem River between the Central and Southern zone. The maximum area under mining is in Sanguem Taluka followed by Bicholim, Sattari, and Quepem. These talukas also have considerable areas under the forest cover and are part of the Western Ghats, rich in biodiversity. Sand mining is another important mining activity in the state. It is primarily fuelled by the construction sector and carried out along the coastal areas.

Along with tourism, mining is an important part of the state's economy and industrial growth. As per Economic survey 2017-18, 38 mining leases were in operation in 2017. However, mining has led to several social and environmental problems in the region. Some of these problems can be attributed to 'illegal' and 'unscientific' mining activities. Iron ore mining is water-intensive leading to drying up of wells in the nearby area, pollution of water bodies and groundwater, biodiversity loss, etc. In some cases, the dust has been attributed to low cashew production.

Impact of Climate Change:

1. Climate change will further exasperate the water scarcity in the mining area for the local population and also for agricultural purposes
2. Mines will as well be impacted by water scarcity
3. Sea level rise and extreme events can cause flooding of mining sites

Adaptation Strategies

Sand mining, which is associated with economic activities and indirectly with number of people, does increase the sensitivity of the coastal system to coastal hazards.[16]

Table 22:Mining related adaptation strategies

[16] [16] Multi-hazards Coastal Vulnerability Assessment of Goa, India, using Geospatial Techniques, NIO, 2014

Sr No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance	Time frame
1	A comprehensive study of Hydro Geology of underground water to be carried out	proposed	Ground water department		Activity	0.5	Multilateral agency	1 year
2	Independent mining audits to ensure compliance with EIA/clearances and other parameters	to be modified	Climate Secretariat or other institutes		Activity	0.5	Own budget and Central Government Contribution	6 months
3	Explore and provide treated water for mines or alternate sources	proposed	PWD		Policy		Others	1 year
4	Resource efficiency and circular economy concept needs to be incorporated into the construction sector to reduce pressure on	under progress	PWD		Policy		Existing Department Budget	1 year

Sr No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Budget	Source of Finance	Time frame
	sand as a resource.							

Approximate financial implications of mining sector expected to be met from climate change plan for ten years are approximately ₹ 5 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.

7.4. **Agriculture and allied sectors**

Agriculture is an important sector in the state. Out of the total state area of 361113 ha. about 131587 ha. is under cultivation. The cultivable agricultural and plantation area had reduced from 3,26,671 ha during 1989-90 to 3, 23,976 ha in 2009 - 10. The area is sown more than once fluctuate between 3 to 6 percent. Conversely, there has been a decrease in the area of cultivable wasteland from 21 to 16 percent. This indicates that there is an awareness to use the irrigation potential for double-crop and greening the State. A large area in Sanguem, Sattari, Canacona, Dharbandoda, and Quepem talukas are under woodland forests and cultivable wastelands. On an average landholding in Goa are small and the average landholding is around 0.84 ha. Like most other coastal States, the people of Goa practice integrated systems of farming, forestry, horticulture, livestock, and off-farm activities.

Goa has only one agro-climatic zone i.e. West Coast Plains & Ghat Region and the state primarily depends on rain-fed agriculture. Paddy, sugarcane, arecanut, coconut are the major crops grown under irrigation. Besides, pulses are taken in rotation. Goa has a very distinct pattern of land use. The sloppy hills are cultivated with cashew interspersed with Kokum; the lower slopes are cultivated with Coconut. Areas with perennial irrigation have multi-storied cropping including Coconut, Arecanut, Black Pepper, Nutmeg, Jackfruit, Pineapple, Breadfruit, etc. The valley along the Nullah & River is cultivated with Paddy in Rabi season. The sandy soil in Coastal areas is planted with Paddy in Rabi season and with legumes and vegetables in the summer season. Khazan lands that are reclaimed by constructing bunds along the tidal rivers and controlling tidal water through an intricate arrangement of sluice gates cover about 18000 ha. These areas are cultivated with paddy only during the rainy season with salt-tolerant varieties and left fallow due to high salinity in dry months.

The State of Goa has around 60.44% of its geographic area under Government forest (2,237.49 sq.km.) One National Park and six Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.33% of its geographical area . There is a substantial area under private forest and a large tract of plantation under cashew, mango, coconut, etc. There are many areas

in Goa which are famous for their Agro Heritage. These include Mayde (Moira) for Banana, Aldona & Khola for Chili, Taleigaon for Bhendi, Kutthali for Brinjal.

The soils of the State are largely acidic in nature having laterite in plains/midlands and in hilly areas while sandy to sandy loam in coastal areas. Brackish water salt pans also exist in the low-lying areas of the coastal regions. About 30 percent of the area of the Goa has shallow soils, 5 percent has moderately deep soils, 46 percent has deep soil and about 7 percent has shallow to very shallow soils.

In the upper reaches of the topography, the soils are coarse and gradually become dense towards the valley regions. The percolation is better up to pediplain areas from hills and gradually decreases in the valley regions. Particularly in the lower areas, i.e. the soil along the river banks and major streams, heavy textured soils are encountered. In some cases, subsoils are affected by acidity. The surface layer of the soil up to a depth of 25 cm. is normally used by the crop plant. About 38 percent has silty clay and gravelly silty clay surfaces soil texture, 26 percent has gravelly clay sand clay texture, and 20 percent sandy loam and loamy sand, 6 percent gravelly sandy clay loam and gravelly clay loam and 5 percent loam and sandy clay loam surface soil texture. The National Bureau of Soil Survey and Land Use Planning [NBSS & LUP], Nagpur has brought out the publication on "Soil Series of Goa" in 2002. In all 32-soil series have been identified in the State. Provided in Annexure III.

Topographically, 13.4% of the area has less than 3% slopes and 5.5% of the area records between 5-25% slopes. Most of the area, which is under rain-fed agriculture, possess 3-5% slope grade.

Agricultural sector plays a vital role in the distribution of regional income and hence, Land utilization, cropping pattern, the extent of inputs and other related factors become very important for proper planning at the micro level so that the share in the State income of particularly the small and the marginal farmers improves.

The government intends to increase the area under organic farming and has set a target of bringing 350 ha under organic farming in the year 2019. It has developed schemes and mechanisms for the same.

Animal Husbandry sector plays is also important for the economy. The State supports around 2.0 lakh livestock population out of which about 72 thousand are cattle, 38 thousand are buffaloes, 59 thousand are sheep and 11 thousand are goats as per the 2010-11 Economic Survey.

Statistics based on 20th Livestock census 2019

Total Livestock Population	**1,32,388**
Buffalo	27,207
Cattle	60,247
Sheep	08

Goat	9,446
Pig	35,480
Total fowl population	2,03,51
Milk production	1.70 LLPD
Milk required	4 Lakhs LLPD
Deficit	2.30 LLPD
Per day Egg Production	1,09,596
Per day Meat Production	19,758 kgs

There is a huge demand in the State for milk, eggs, and meat and also their products. Milk required is about 4 Lakh Litres Per Day (LLPD). In comparison to this, State is producing 1.40 LLPD milk, thus having a deficit of 2.80 LLPD. In FY16-17 average milk collection was 66,000 liters/day in 2016-17 with 1395 animals and has gone up to 72,000 litres/day till December 2017 with the purchase of 1559 animals by the beneficiaries under Kamdhenu (Sudharit) Scheme. A 10 TPD biogas plant working on the cow dung unit has also been set up. This deficit predicts the huge demand for milk production and milk marketing in the State. The grazing area for cattle is often encroached by mining, industrial and housing activities. This has largely hampered the availability of green fodder and thereby decreased production.

Fisheries: Goa has 104Km. of coast length, 250Kms. of inland waterways and about 100 ha. area covered under inland water tanks provide huge opportunities for fishing activity. The coast is full of creeks and estuaries formed by these rivers which provide a good shelter for fishing crafts. Annual fish landing is about 95000 MT. The export of marine fish products earns a good amount of foreign exchange. As a result, there has been a proliferation of few invasive species of a shrub-like Lantana and fishes like African Catfish and Tilapia. These have established in many pockets including wild habitat and pose danger to native flora and fauna.

Administrative set up: Besides Zonal Agriculture Office at each Taluka level there is Farmer Training Centre at Ella, Old Goa, State Department supported Krishi Vigyan Kendra at Margao and Three-State Agriculture Farms. There is also ICAR set up in Goa through ICAR Research, Complex for Goa at Ella and KVK. As regards Animal Husbandry there is the presence of Veterinary Dispensary at the Panchayat level.

Challenges:

Agriculture and allied sectors face several unique challenges in Goa:

1. **A decline in interest in agriculture:** One of the major problems being faced is the drifting interest from agricultural activities towards jobs in other sectors like tourism and mining. In the year 1960-61, 64 percent of the workforce engaged in agriculture and allied activities, which has declined to 16.6 percent in 2001. While decadal censuses indicate a continuous decline of workforce in the agriculture sector, the agriculture production in the State is showing an increasing trend. However, its contribution to GSDP has declined sharply.

2. **Erosion of soil and deterioration of soil quality** has been observed in large agricultural areas and varies from light to heavy erosion. These areas are mostly fallow or grazing lands or under bushy vegetation.
3. **Labour wages have more than doubled over the decades, and very few people are available to undertake highly skilled jobs like Coconut/ Arecanut harvesting.**
4. **Loss of Agro heritage sites:** These areas are rapidly developed to accommodate increasing demand for Housing and there by affecting land availability for agriculture.
5. **EROSION OF LOCAL GERMPLASM and introduction of GMO seeds**
6. **Khazan Land** was earlier maintained through regular contribution and surveillance and Tenant Association and is currently under the Soil and Water Conservation Department. The traditional system of maintaining bunds by using local clay is substituted by Cement and boulder. Many times, these bunds arc breached intentionally to promote prawn culture which though provides high return but eventually leads to increased salinity. There is also increasing danger to the bund due to heavy traffic of high capacity barges which generate waves and lead to erosion of the bunds. If these bunds are not maintained regularly then there is a danger of losing these precious agricultural ecosystems.
7. **Unavailability of water** during the non-rainy season for irrigation of crop and other agricultural activities
8. **The proliferation of invasive species:** Invasive species of a shrub-like Lantana and fishes like African Catfish and Tilapia is increasing. These have established in many pockets including wild habitat and pose danger to native flora and fauna.
9. **Quality of water:** Turbid or poor-quality water can impact the aquatic food chain

Schemes, Policies and Initiatives

Agriculture and allied sector are a priority for the government of Goa. To overcome the challenges and other issues being faced government has taken several steps in the last decade and assisted to strengthen the sector.

One of the main initiatives of the government has been the development of Vision 2025 for agriculture and allied sectors. This plan envisages doubling of farmer's income by the year 2022 and a substantial increase in the GDP from the agriculture and allied sector.

Some of the other schemes, policies and initiatives are:

- To reverse this order of deterioration of natural resources and support livelihood activities for the inhabitants' watershed management has been taken up as the functional and planning tool for conservation of natural resources and sustainable development by the Government of India through its Common Guidelines for Watershed Development Projects 2008. The State of Goa, through its State Level Nodal Agency for the same, will be formulating State-Level Perspective Plan (SLPP) for Integrated Watershed Management Project (IWMP) in Goa for 15 years period (i.e. 2010-25).
- **Greening the Young mind:** To sustain agriculture in the long term, there is a need to bring youth into farming. To expose school students to vegetable cultivation, a

comprehensive program of training followed by actual cultivation of vegetables was taken up in 90 schools through the Agriculture Technology Management Agency (ATMA) in both districts

- **Development of e-Krishi Card:** Bringing technology to agriculture and making it simple to access all agricultural schemes.
- **Shetkari Aadhar Nidhi:** The scheme is implemented for grant of compensation to farmers who suffer a loss of crop/produce due to natural causes like unseasonal rains, floods, droughts, landslides, siltation, natural fire/lightning, an epidemic of pests and diseases, damage due to wild animals, etc.
- **Mechanization in Agriculture:** The objective of the scheme is to promote agricultural mechanization to overcome the shortage and high cost of manual labour.
- **Assistance in agricultural inputs like subsidy on setting up of irrigation facility, organic inputs, etc.**
- "**Rashtriya Krishi Vikas Yojana**" (RKVY), a government of India flagship program, is being implemented in the state
- Extension of financial help for growing most of the horticultural crops like cashew, mango, chikoo, pinapple, banana, coconut, and spices.
- **Control of soil erosion**: Soil erosion can be improved by taking up of afforestation, plantation crops, etc. Agronomical measures like the introduction of vegetative hedges, taming of gullies have to be taken immediately in some of the areas.
- **Kamdhenu Scheme (Sudharit)**: The scheme proposes to increase milk production in the state. Under this, it is ensured that the cattle market was brought into the State as "Cattle Melas" wherein farmers could purchase the animals of their choice within the State itself, thus saving on time and money.
- **Crop Production and Input Management Scheme:** Assistance for High Yielding Certified Seeds, Assistance for Fencing Crop demonstration on cereals (Hybrid Rice) Hybrid paddy Mini-kits Contingency Plan Development in Sugarcane Plant Protection Mechanization in Agriculture are some of the measures under this head.
- **Development of Agricultural Extension**: Agriculture and Home Science Demonstration Camps/Courses are being undertaken. Conducting three days Institutional courses, Exhibition and Shows, Best Farmer Support for Higher Education in Agriculture, Conducting Krishi Melas Publicity and Publication of technical literature and Encouragement of Kisan Call Centre
- **Development of Manure Scheme:** Soil Sample Collection and Analysis Assistance for Soil Health Improvement
- **Organic farming: Organic Manure Unit** assistance for construction of Biogas units and Export oriented Certification of Organic Farming
- **Soil and Water Conservations Scheme:** The scheme has the following objectives - Repairs and maintenance of notified ponds protecting Khazan agricultural lands and provide assistance for Protection of embankments Revitalization of the Waterbodies.
- **Support price and productivity linked incentive scheme**: Support Price for Paddy Support price to sugarcane Support price to Areca nut productivity linked incentives for oil palm crops

- **Western Ghat Development Programme**: The scheme is aimed at restoration of the eco-system and upliftment of living of the people of western Ghat.
- Green fodder scheme to ensure fodder to the cattle.
- Legislation such as the Marine Fisheries Regulation Act and the Monsoon Ban must be strictly observed and enforced
- Increasing the **gobar gas plants** – Introducing the same in goushala's and in stray cattle ponds
- Optimizing the use of waste from indigenous and non-indigenous cattle for therapeutic and non-therapeutic uses.
- Minimizing the use of closed paddock system and shifting to open paddock system to reduce methane emissions.
- The Self Help Groups' involved in vermicompost production should be registered by Directorate of Agriculture so that their produce can be sourced under Paramparagat Krishi Vikas Yojana (PKVY) and organic farming.
- 500 organic farming clusters have been formed involving more than 10000 farmers under PKVY.

Impact of Climate Change on Agriculture in Goa

While the above-mentioned measures assist agriculture, climate change continues to pose new threats and disrupt the plan:

- A threat to production levels and quality due to the rise in ambient temperature and changing season patterns:
  Evidence and observations have been made by several stakeholders which suggest a shift in the time frame and duration of ripening of local popular fruits and vegetables. A change in the quality of produce, specifically its taste and smell has been associated with it. Farmer preparedness for harvesting, labour availability are several other factors that would require adjustment to the change.
- Reduction in Availability of Water for irrigation

An increase in high-intensity rainfall scenarios as predicted and a decrease in slow and long spells of rainfall will impact soil runoff and water availability.

- Degrading Soil health:

IPCC's special report suggests that Soil erosion from agricultural fields is estimated to be currently 10 to 20 times (no-tillage) to more than 100 times (conventional tillage) higher than the soil formation rate (medium confidence). Climate change exacerbates land degradation, particularly in low-lying coastal areas, river deltas[17]. Thus, maintaining soil health and increasing focus on this would be essential for Goa's agriculture policy.

- Erratic flood & drought condition cause loss of livestock due to flooding
- The emergence of new pests and pathogens

[17] https://www.ipcc.ch/site/assets/uploads/2019/08/4.-SPM_Approved_Microsite_FINAL.pdf

- Heavier precipitation events and floods accompanied by seal level rise is having a detrimental impact on the khazan land which are crucial for rice cultivation in the state
- Erratic rains and Long dry periods impact the quality and quantity of produce
- Stress to livestock due to heat

Synergy with National Mission and SDG

Sustaining agricultural productivity depends on quality and availability of natural resources like soil and water. Agricultural growth can be sustained by promoting conservation and sustainable use of these scarce natural resources through appropriate location specific measures. National Mission on Sustainable Agriculture (NMSA) derives its mandate from Sustainable Agriculture Mission which is one of the eight Missions outlined under National Action Plan on Climate Change (NAPCC). NMSA caters to key dimensions of 'Water use efficiency', 'Nutrient Management' and 'Livelihood diversification' through adoption of sustainable development pathway by progressively shifting to environmentally friendly technologies, adoption of energy efficient equipment's, conservation of natural resources, integrated farming, etc. Besides, NMSA aims at promoting location specific improved agronomic practices through **soil health management, enhanced water use efficiency, judicious use of chemicals, crop diversification, progressive adoption of crop-livestock farming systems and integrated approaches like crop-sericulture, agro-forestry, fish farming,** etc.

Several SDG's are partially linked to agriculture. However, SDG 2 i.e. End hunger, achieve food security and improved nutrition and **promote sustainable agriculture**, is in particular most relevant to this SAPCC. The SDG2 targets that the SAPCC interventions are linked to are:

- Target 2.3 - By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment
- Target 2.4 - By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
- Target 2.5 - By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits

arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

- Target 2.a -Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries
- Target 2.c - Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility

Adaptation Strategies for Agriculture and Allied Sector

1. **Maximizing the agricultural land:**

- Human Animal conflict: Availability of drinking water and green fodder/wild fruits to the animals in forest to be ensured by Forest Department. Management of Accasia & Eucalytus in phased manner and planting local fruit bearing plants.

- Areas that are fallow and not being currently used should be brought under agriculture by encouraging landholders. Planting of flowering trees along roadside would facilitate promotion of Apiculture. Soap nut, Taman, etc. IFS&IPM:- Effective use of IFS & IPM will reduce use of chemical fertilizers and pesticides resulting in cleaner foods availability and reduced pollution.
- Identification of areas under non-cultivation in the State and encouraging landholders to cultivate them by providing some incentives.

2. **Climate Research in Agriculture**

- Development of regional knowledge bases on climate change impacts and adaptation strategies for a farming systems approach, taking into account information such as crop yield responses to climate, crop quality response, water availability for rain-fed and irrigated crops, and livelihood strategies
- Identify and develop indicators for climate risks, including thresholds and acceptable coping ranges of the sector and specific crops, which are critical to improving climate risk management
- Increase overall investments in agricultural research and development.
- Technological innovation, research in agriculture will be promoted.

The ICAR Goa would be the primary research organization which will work in conjunction with and State agriculture department

3. **Increasing farmer income:**

The State has already taken various measures to promote agriculture in the State of Goa. Organic farming and market connection are important factors. In addition, it support's existing farmers associations for the same.

4. **Encourage education in agriculture and educate farmers**

- Improve access by farmers, herders, fishers, and foresters to timely weather forecasts and response options, which can enhance decision making and responses to a changing climate.

• Provide training and education programs as well as agricultural advisory services to help implement agricultural practices and technologies that are more resilient to climate change.

- Advisory to farmers through Use of modern technology like Social Media, TV etc to issue advisory to farmers and general public on effects of climate change and ways to mitigate them.

5. **Fisheries management**

- Adopt changes in management philosophy, such as integrating fisheries and aquaculture management into coastal zone management, to increase the coping ability of small communities to sea-level rise.
- Breed fish species that are tolerant to high water temperatures and improve the management of fish stocks, which can be effective measures to reduce climate change impacts on fisheries.

- **Livestock management:**
  Breed livestock that is tolerant to adverse climatic conditions and improves the management of stocking rates and pasture rotation to enhance the climate resilience of livestock production. Modify and construct livestock shelter to reduce climatic stress, especially heat stress on livestock and explore the choice of natural material for the same.

6. **Managing the cropping pattern:**
   - Implement farm management practices, such as crop diversification, changing planting dates, and adjusting the application of nutrients, fertilizers, insecticides, and pesticides, to effectively adapt to alterations in the growing season and irrigation opportunities.
   - Develop adequate systems for weather data collection, analysis, and prediction.

7. **Khazan Lands:**
- Protecting khazan lands, 'Puran sheti' a unique among other types of farming practices in Goa from inundation and other climatic impacts requires the involvement of local farmers association and a structured mechanism for monitoring the same.
- Investment in coastal flood control structures which could be a combination of hard infrastructures like gates, dykes and natural infrastructure like mangroves.

8. **Gene Bank preservation:**

Goa has several unique varieties of rice and other crops. Documentation of the traditional practices and protection of rice variety and other crops through gene banks is essential

9. Farm Insurance:

Identify and encourage farm insurance measures that cover climate vulnerabilities like loss of crop due to temperature variability or climate-induced pest invasion.

Table 23: Adaptation Strategies for Agriculture and Allied Sector

Sr. No	Intervention	Status	Responsible agency	Barriers & Gap in implementation	Intervention Type	Time frame	Budget	Source of Finance
1	Emergency evacuation plan for livestock during flooding	proposed	Disaster management		Others			
2	Heat stress relieving system in cow sheds	proposed	Department of Animal Husbandry and Veterinary service		Others			
3	Demarcated area for such livestock relief	proposed	Department of Animal Husbandry and Veterinary service	Land availability	Others			
4	Farm insurance and livestock insurance for climate stressors like temperature need to be explored and established	proposed	Department of Animal Husbandry and Veterinary service, Agriculture department	Terms and conditions to define the stressors and availability of ready to use private sector insurance products	Scheme			Insurance
5	Gene Preservation Bank	proposed	Agriculture department	Cost intensive	Activity			Own budget and Multilateral agency
6	Investment in coastal flood control structures which could be combination of hard infrastructure like gates, dykes and natural infrastructure like mangroves	proposed			Activity			Own budget and Multilateral agency

Sr. No	Intervention	Status	Responsible agency	Barriers & Gap in implementation	Intervention Type	Time frame	Budget	Source of Finance
7	Develop adequate systems for weather data collection, analysis and prediction.	to be modified			Activity			NAFCC
8	Formation of strategy Breed livestock that are tolerant to adverse climatic conditions	to be modified	Animal Husbandry		Scheme			Own budget and Central Government Contribution
9	Integrating fisheries and aquaculture management into coastal zone management, to increase the coping ability of small communities to sea-level rise.	to be modified	Fisheries department		Activity			Own budget and Central Government Contribution
10	Encourage breeding fish species that are tolerant to high water temperatures and improve the management of fish stocks	proposed	Fisheries department		Activity			Existing Department Budget
11	Enhance access of all stakeholders of agriculture and allied sector to weather information in a format that is usable for their activity	proposed	Climate secretariat		Activity			Own budget and Central Government Contribution
12	Provide training and education programs as well as agricultural advisory services to help implement agricultural practices and technologies that are more resilient to climate change.	to be modified	Agriculture department		Activity			Existing Department Budget

Sr. No	Intervention	Status	Responsible agency	Barriers & Gap in implementation	Intervention Type	Time frame	Budget	Source of Finance
13	Provide enablers for credible and certified organic farming	under progress	Agriculture department		Activity			Existing Department Budget
14	Enhancing market connect for farmers	under progress	Agriculture department		Activity			Existing Department Budget
15	Climate Research in Agriculture	proposed	ICAR and Agriculture department		Activity			Own budget and Central Government Contribution
16	Maximizing the agricultural land by utilizing fallow land	proposed	Agriculture department		Activity			Existing Department Budget

Approximate financial implications of agricultural sector expected to be met from climate change plan for ten years are approximately ₹ 50 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.

7.5. Forest

Goa presents an astonishing diversity of endemic species, habitats, and ecosystems. The impact of intensified economic activities on biodiversity in this region is visibly noticeable.

On the other hand, Goa the smallest state, with just 3702 sq. km. geographical area is having a good forest cover with 1,225.12 sq. km of recorded Government Forest which is over 33% of the total geographical area of the State. Out of this 62% is designated as 7 Protected Areas, 6 biodiversity-rich and ecologically sensitive Western Ghats and one in Mangrove forest at Chorao island. The Wildlife Sanctuaries and National Parks cover an area of 75,496 ha. constituting 20.39 % of the geographical area of the State, the highest in the country. As per the "India State of Forest Report 2017" published biennially by Forest Survey of India, Dehradun, the Forest Cover of Goa is 60.21% and the total Forest and Tree Cover of Goa is about 68.94%, which includes forests on private lands, plantations such as cashew., and other tree crops. Its entire hills have been declared as Protected areas.

Forest Cover	2229Sq.km
Total Recorded Forest Area	1225 Sq.km.
Tree Cover	323Sq.km.
Total forest and tree cover	2552 Sq.km.
National Park	
Bhagwan Mahaveer National Park	107 Sq.km
Wildlife Sanctuaries	
1. Mhadei Wildlife Sanctuary, North Goa	208.48 Sq.km
2. Bhagwan Mahaveer Wild Life Sanctuary, North Goa.	133 Sq.km
3. Netravali Wildlife Sanctuary, South Goa.	211.05 Sq.km
4. Cotigao Wildlife Sanctuary, South Goa.	85.65 Sq.km
5. Bondla Wildlife Sanctuary and Zoo, North Goa	8.00 Sq.km
6. Dr. Salim Ali Wild Life Sanctuary, North Goa	1.78 Sq.km

There is no further potential to increase the forest cover of the state, however, there is a possibility to increase the green cover and increase the quality of the forest by increasing the carbon content.

Because of this, about 44 sq. km. forest areas in private lands have been brought under protection as Private Forests and remaining areas are being surveyed which are having natural tree cover. These areas support and nurture a variety of ecosystems of life forms – both floral and faunal, particularly in Western Ghat areas of the State located in Sanguem, Canacona, Sattari, and Dharbandora Talukas.

Marine and coastal ecosystems, including mangroves, seagrass beds, coral reefs, and associated biota. This system is threatened due to pollution and over-exploitation. Climate change will only exasperate the impact.

Schemes, Initiatives and Policies

Forest Department is entrusted with overall conservation, protection, management, and development of forests and wildlife. The Goa's Forest Department through various State and Central funded projects has been protecting and enriching its existing forest areas in a highly scientific manner.

Documentation of biodiversity has been and is being carried out under various activities like PBR, Documentation of Flora and Fauna of each Sacred Groves and labelling of important plant species.

Several social forestry activities are being taken up. In coastal areas plantation of Casuarinas and Protection & Maintenance of Social, Forestry plantation is planned.

The state's first biodiversity heritage site has been registered at Purvatali Rai located in Bicholim Taluka. Mining is prevalent in this region and registering the site as biodiversity

heritage will protect several medicinal plants and recharging of aquifers. State Biodiversity Board is working towards getting several other sites in state registered as biodiversity heritage sites.

Community Response Network: The Department in collaboration with the IUCN conducted a workshop to develop Community Response Network for Marine Conservation in Goa to train Forest staff, lifeguard/ coast guard to monitor report and document the marine mammals stranding incidences and carcasses in a timely, efficient manner.

To mitigate human-animal conflict, this Department maintains 24 x 7 Rescue Squad/Centre at Campal, Margao, and Cotigao for rescuing wild animals under stress.

Satpal Arboretum consists of 82 plots of different species of trees, shrubs, vines, etc. which are grown for study and research.

Goa Forest development corporation is also carrying out rejuvenation of Cashew Plantations/ estates and conducts the auction for sale of rights for collections of Cashes, nuts and apples, maintenance and development of Rubber Plantations, extraction of the latex, processing it to rubber sheets and selling the same.

Eco-tourism facilities: Forest Department has established eco-tourism complexes at Bondla, Mollem, and Cotigao for visitors and to improve the livelihood of local people. 3,33,657 tourists have visited the National Park and Wildlife Sanctuaries this year. Rs. 37.23 lakhs of revenue have been generated through the sale of Forest produce and Rs. 260.29 lakhs of revenue have been generated through Eco-tourism and allied activities. Plantation and other Conservation related activities have also generated direct employment to the local youths.

Impact of climate change

Forest Fire: Climate change has resulted and will further result in a change in temperature and humidity in Goa. Temperature rise is predicted to be up to 3 to 4 degrees. Ecological systems are vulnerable to these changes. Forest fire is a phenomenon that can get intensified due to climate change. Though enough documented proof is not available on whether forest fire incidents have increased in Goa due to climate change or human activities. The trend depicts the vulnerability of Goa's forests to fires and this can get exasperated due to climate change by 2040.

Table 24: Forest Fire Incidents in Goa from 2014-15 to 2018-19

Year	No. of incidents of forest fires	Area involved in ha.
2014-15	2	11.07
2015-16	24	44
2016-17	92	153.42

2017-18	47	130.80
2018-19	38	113.29

- **Invasion of alien species** and enhanced spread and colonization of the same can impact the native species.
- Changes in the flowering time and fruit ripening time due to change in temperature. This can lead to alternation incomplete cycle of the plant.
- The shift in forest ecosystem
- Changing rainfall patterns could lead to water availability constraints in certain patches.
- Soil erosion can have drastic impacts

- **Change in Forest Types and Structure**: Climate change will cause shift/ changes in the flowering and fruit ripening time due to change in temperature. This can lead to alternation incomplete cycle of the plant.The functions of forest ecosystem might be adversely affected due to climate change.

- **Extreme weather events including change inrainfall patterns** could lead to flooding and scarcity of water and affect overall water availability in various parts of the state. Soil erosion in heavy rains and landslidescan have adverse impact on agriculture.

State REDD+ Cell as per National REDD+ Strategy is as follows:

Deforestation and forest degradation account for approximately 11 percent of carbon emissions, more than the entire global transportation sector and second only to the energy sector. Reducing emissions from deforestation and forest degradation (REDD+) is a mechanism developed by Parties to the United Nations Framework Convention on Climate Change (UNFCCC). It creates a financial value for the carbon stored in forests by offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. Developing countries would receive results-based payments for results-based actions. REDD+ goes beyond simply deforestation and forest degradation and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. State REDD+ Cell, headed by Principal Chief Conservator of Forests has been constituted for implementation of National REDD+ Strategy in Goa and has 8 other members.

The terms of reference of the State REDD+ Cell as per National REDD+ Strategy is as follows:

a) Facilitate the implementation of National REDD+ Strategy in the State

b) Preparation of State REDD+ action plan, sub-national/ State level reference emission level/ reference level. Forest monitoring system and safeguard information system (SIS).

c) To oversee REDD+ Project Proposal preparation and implementation through Community Forestry, Van Panchayats / Village Forest Protection Committees.

d) Development of State REDD+ Learning/ Knowledge sharing platform for exchange and sharing of knowledge.

e) Explore the possibilities of REDD+ financing, development of REDD+ projects and facilitate REDD+ benefit sharing mechanism

f) Arrange technical and institutional supports for implementation of REDD+

g) Monitoring of REDD+ implementation in the state

h) To approve and submit the plans and projects for REDD+ implementation to the NDE-REDD+, Government of India for financial support.

i) To organize training and capacity building seminars and workshops for the officials of the State Forest Department and village level institutions

j) To institutionalize data collection and management, and adherence to safeguards

k) To devise mechanism to absorb lessons from pilots, as an input to the national and international policy processes and development.

Synergy with National Mission and SDG

The Green India mission, which aims to protect, restore and enhance India depleting forest resources through increase forest/tree cover; improve/enhance eco-system services like carbon sequestration and storage (in forests and other ecosystems), hydrological services and biodiversity; along with provisioning services like fuel, fodder, and timber and non-timber forest produces (NTFPs); and increase forest based livelihood income of about 3 million households.

It is an endeavour of the state to increase the green cover wherever possible to achieve objectives of implementing the Green India Mission.

SDG 15 i.e. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

- By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.
- By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.
- By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.
- By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development.
- Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species.
- Promote fair and equitable sharing of the benefits arising from the utilisation of genetic resources and promote appropriate access to such resources, as internationally agreed.
- Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products.
- By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species.
- By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.
- Mobilise and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems.
- Mobilise significant resources from all sources and at all levels to finance sustainable forest management and provide adequate. incentives to developing countries to advance such management, including for conservation and reforestation.
- Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities.

Strategies for climate impact management

Strategies to protect and enhance forest availability generally have cross-cutting impacts i.e. providing both mitigation and adaptation. The strategies for Goa are:

a. Enhance the forest quality
b. Restore and increase the coastal defence mechanism
c. Prepare a strategy to prevent and control forest fires
d. Afforestation and Plantation outside the forest

e. Support private forest owners in the sustainable management of their forests and derive economic benefit
f. Water and Soil conservation
g. Capacity building of field staff
h. Promote Ecotourism

Action Plan to address Forest related Climate Change:

Action Point 1: Enhancing quality of existing Forests

1. **Conversion of Open Forest into Dense Forests**: Around 357 sq km of recorded forest area falls under open forest which will be converted into dense through Assisted Natural Regeneration (ANR).
2. Out of 1225 sq km recorded forest area, 1173 sq km area is having forest cover. Out of 52 ha remaining, suitable area will be explored for afforestation.
3. Conservation and increase the Mangrove cover wherever possible.
4. Scientific removal of invasive species and conversion into natural forest.
5. Prevention and control of forest fires.

Action Point 2: Afforestation and Plantations outside forests

1. Linear plantations along the National and State Highways, Rural roads, canal & river embankments and railway line.
2. Greening of urban spaces through appropriate afforestation programme like Nagar Van (City Forest), Woodlands, Coastal Greenbelts, offices and residential complexes, Biodiversity Parks etc.
3. High Density Plantations using local forestry species in degraded lands including abandoned mining areas.
4. Encouraging people to undertake mass planting programme through Van Mahotsav and other focused campaigns.
5. Increasing nursery stock for doubling free distribution of saplings.
6. The department is reaching out to other Government departments, institutions offering support in afforestation/greening of their lands, office and residential complexes.
7. Training of local youths as Nature Guides and Community Foresters for promoting forestbased livelihoods and improving stakeholders base for conservation.
8. Restoration/greening of ongoing infrastructure projects on their completion.

Action Point 3: Support to Private Forest owners in sustainable management of their forest and deriving economic benefits

1. There is significant area under Private Forest in the State which requires sustainable management. The department will support private forest owners to conserve and improve their forests through scientific interventions (Working Schemes) for sustainable harvesting of forest products etc. and economic viable programmes such as ecotourism.
2. Exploring modern woodbased industries for creating demand for wood from tree growers including Private Forest owners.

Action Point 4: Promote Agro Forestry and Business Models

1. Promotion of Agro forestry in farm lands and agricultural fallow lands. Suitable policy will be made in consultation with Agriculture Department and land owners to develop suitable Agro Forestry model on these lands.

Action Point5: Conservation of mangroves and coastal belts:

1. Strengthen marine and coastal ecosystems, including mangroves, seagrass beds, coral reefs, and associated biota. This system is threatened due to pollution and over -exploitation. Climate change will only exasperate the impact.
2. Interlinkages of coastal people's livelihoods with conservation through sustainable ecotourism and aqua-culture etc.

Action Point 6: Addressing other critical issues:

1. Improving effectiveness and efficiency of various processes in implementation of forestry programme.
2. Building capacity of the department at field levels for efficient and timely utilization of large afforestation funds coming through State Plan, CAMPA and financial support from CSS etc..
3. Hiring of part time staff and human resource for increased afforestation targets.
4. Sensitization of Finance and Account Departments for timely release of funds and accounting process.
5. Keeping the procedures simple with in-built flexibility and decentralized approach.
6. Economic viability of afforestation and tree plantation by farmers and land owners, efficient utilization of wood through modern hi-tech wood-based industries for creating demands and fair priced marketing interventions. Incentivise and not penalize the tree grower and Forest owners.
7. Policy support for extensive use of wood in the country which will help more tree plantation in the private land including farmers.

Table 25: Adaptation Strategies for Forest

Sr.No	Intervention	Status	Responsible agency	Barriers & Gap in implementation	Intervention type	Budget (in Lakh Rupees) (Approx)***	Source of Finance	Time frame
1.	Improvement of quality of forests and their resilience to change climate	Goa has about 30 percent of area under open forests and its density is required to be improved.	Goa Forest Department	Fund allotment and availability of forest land	Afforestation/ Enrichment plantation/ Aided Natural Regeneration of Open Forests and Medium Dense Forest. Action: An area of 50 ha/year will be taken up for ANR/plantation for conversion of open forest into dense forest	1000.00	State Plan, CAMPA* and CSS** funds	10 years
2.	Restore and strengthen coastal defence mechanism by natural means viz restoration and improvement of mangrove vegetation and coastal belt plantation.	Coastal belts are vulnerable due to anthropogenic and factors of climate change		Insufficient Fund allotment and land availability for mangrove plantation	1.Restoration of damaged and degraded mangrove areas is being done under this intervention. 2. Shelter belt/ Coastal belt planation 3.Nurseries for mangroves and suitable plants 4. Provide suitable incentives/ livelihood support to people in conservation and management of mangroves in plantation, protection activities, ecotourism in backwaters/ creeks and aquaculture, pisciculture etc.	500.00	State Plan and Mangrove Management Action Plan	10 years
3.	Prepare strategy to prevent and control forest fires	Forest Fire is common in summer season from March to June primarily due to anthropogenic factors.		Timely Fund allotment	Multipronged strategy involving both prevention and timely effective control of forest fires: 1. Preparation of State Action Plan on forest fire 2. Creation of effective and efficient task force of forest staff and fire watchers by regular training and capacity building, supported by adequate communication, firefighting equipment. 3. Design and implement appropriate awareness campaigns for pre fire season sensitization of local communities 4. Periodic creation of new firelines clearing of fire lines, removal of dry bamboo, other inflammable materials from forest floors, controlled burning. 5. Strengthening communication network, infrastructure& control room	1000.00	State Plan, CAMPA and CSS for Fire Prevention and Management	10 years
4.	Afforestation and Plantation outside the forest for increase in ToF			Timely availability of funds	Free distribution of quality seedlings and tree plantation by involving different institutions Roadside planation	1500.00	State Plan, CAMPA and CSS	10 years

5.	Support private forest owner in sustainable management of their forests and derive economic benefit	People fear of losing the right to use their land in view of identification of their tree bearing lands as private forests, which creates negative attitude towards planting trees		Regulating provisions under the Forest Conservation Act, 1980	Create supportive policy and Legal framework by providing suitable incentives to tree growers under agroforestry programmes and develop market linkages.	25.00	State Plan	5 years
6	Soil and Moisture conservation	Efforts are being made by Forest Department for soil and moisture conservation if forests and protected areas, however these need to be expanded substantially.		Lack of sufficient funds	Adequate soil and water conservation measures for recharge the natural aquafers and retain water for dry period to improve the habitat for wildlife and control man animal conflict. Soil and water conservation measures like pond, check dams, bunds, gabion check dams, waterholes etc. in the watershed	2000.00	State Plan & CSS	10 years
7	Strengthening of infrastructure & Capacity building of field staff	Insufficient infrastructure in forest areas in terms of mobility, communication, and accommodation of staff.	Goa Forest Department	Inadequate Fund allotment	1. Construction and repair of new and existing quarters, forest road / track points, protection camps enhanced mobility communication. 2. Organizing training, seminars, workshops for frontline staff on forest and wildlife conservation etc. 3. Create effective linkages /network with adjoining States of Maharashtra and Karnataka.	5000.00	State Plan, CAMPA and CSS schemes	10 years
8	i.Promote Eco-tourism in select forest areas by employing local population	Local people in forest fringe villages have not been adequately involved in protection/ conservation due to lack of incentives.	Goa Forest department in collaboration with Tourism Department	Lack of clear policy framework, Fund constraints,non- availability of sufficient local entrepreneurs	Increasing effective people's participation in conservation through multipronged strategy: 1. Preparation of Eco-tourism policy with Forest Department to play facilitative role. 2. Creation of essential infrastructure likeNature Education Centres, Nature Camps etc. 3. Improving Forest roads / trek routes, watch towers & protection camps & enhanced mobility 4. Encouraging local communities to take up ecotourism activities in neighbouring protected areas	1500.00	State Plan, and other CSS schemes	5 years
	ii. Skill development of local population to assist as nature guide and related livelihood activities		Goa Forest Department	Lack of sufficient funds	1.Organizing trainings, seminars, workshops for local people on forest and wildlife conservation 2. Help local communities in obtaining suitable benefits through sustainable use of minor forest produce biodiversity and ecotourism etc. 3. Promotion of ecotourism, organization of nature awareness camps, bird walk, bird festival, publication of brochure, pamphlets, poster, books and films etc. on nature conservation for generating employment to local people	1200.00	State Plan, and Central Government contribution and CSS.	05 years

9	Prepare strategy to control ingress of invasive species and prepare plan for future protection of forest from invasive species	Conversion of areas under invasive and exotic species is urgently required	Goa Forest Department	Lack of funds	Eradication of Eupatorium, replacement of *Acacia auriculiformis*, *Eucalypus*sppetc by suitable local species	5000.00	State Plan, CAMPA and other CSS schemes	10 years
10	Research on the impact of changing climate pattern on the forest and prepare plan for forest rejuvenation	There is insufficient knowledge and research on impact of climate change on forest types and wildlife	Forest Research & Training Institute, Goa Forest Department	Lack of funds	1. Setting up of 08 field research stations for research on climate change and forestry issues. 2. Setting up of State Forest Research Institute Goa for conducting collaborative research, training etc. on various aspects of forest, biodiversity and climate change related issues.	2000.00	State Plan, and Multilateral agency	5 years
11	Urban Green Enhancement / improvement of quality of life in cities-	Need to increase green cover in and around urban areas & educating people about the value of forest, biodiversity to general public	Goa Forest Department	Lack of funds	Creation of City Forest (Nagar Van) in various urban centres, Gram Upvan in villages, School nursery, Biodiversity park, Avenue Plantation etc. public engagement on greening Creation of Nagar Van, Gram Van by engaging local public	5000.00	State Plan & CAMPA	5 years
12	Protection and improvement of wildlife habitat	Need to enhance measures for conservation of wildlife including marine wildlife	Goa Forest Department	Lack of funds	Measures required to improve wildlife habitat by creation of grasslands, planting suitable fruit bearing trees and creation of waterbodies and adequate protection	5000.00	State Plan, CAMPA and CSS schemes	10 years
13	Promotion of Agro-forestry, increase in Tree Outside Forests (TOF) Appropriate Scheme – Policy implementation Government facilitation (i) Exemption of trees spp for Transit (ii) Green credit scheme (iii) Supply of quality planting material	Emphasis is to help local people earn by planting fast growing agro forestry species	Goa Forest Department	Lack of funds	Multipronged strategy: i Exemption of tree species grown by farmers and other landowners on private land ii. Helping farmers and landowners in obtaining good quality planting materials for agroforestry, building their partnership with Wood Based industries and supporting through various CSS and State plan Schemes iii. Facilitation in marketing of timber through marketing linkages iv. Promotion of modern wood-based industries for meeting national demand of wood products and furniture.	1000.00	State Plan, CAMPA and CSS schemes	5 years
			Total			**31725.00**	31725	

Note:

* CSS:- Centrally Sponsored Schemes.

** CAMPA:- Compensatory Afforestation Fund Planning and Management Authority.

*** Budget is based on current schedule of rates

Approximate financial implications of forest sector expected to be met from climate change plan for ten years are approximately ₹ 25 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.

7.6. Human Health

Human health is of paramount importance in the overall wellbeing and productivity of a state. Goa has 13 government hospitals with 3000 beds and 29 community/primary health centres and 30 dispensaries. It has about 2756 beds in private hospital[18].

Developing countries face substantial vulnerabilities to the current and projected health risks of climate change. The health-related risks are not just dependent on climatic factors but also the exposure of the population to those risks.

The health statistics in the state indicate a rise in several vector-borne diseases is the last five years.

Table 26: Vector Borne Diseases in Goa from 2014 to 2019

Year	Malaria Indigenous cases		Malaria Imported cases	J.E	Dengue	Chikungunya	Filariasis
	PF	Total					
2014	42	824	4624	Nil	168	49	Nil
2015	75	651	3802	1	293	32	Nil
2016	130	742	4060	1	150	49	Nil
2017	75	653	3427	Nil	235	48	Nil
2018	50	377	3485	3	335	77	Nil
2019 till Oct.	46	231	1731	1	467	245	Nil

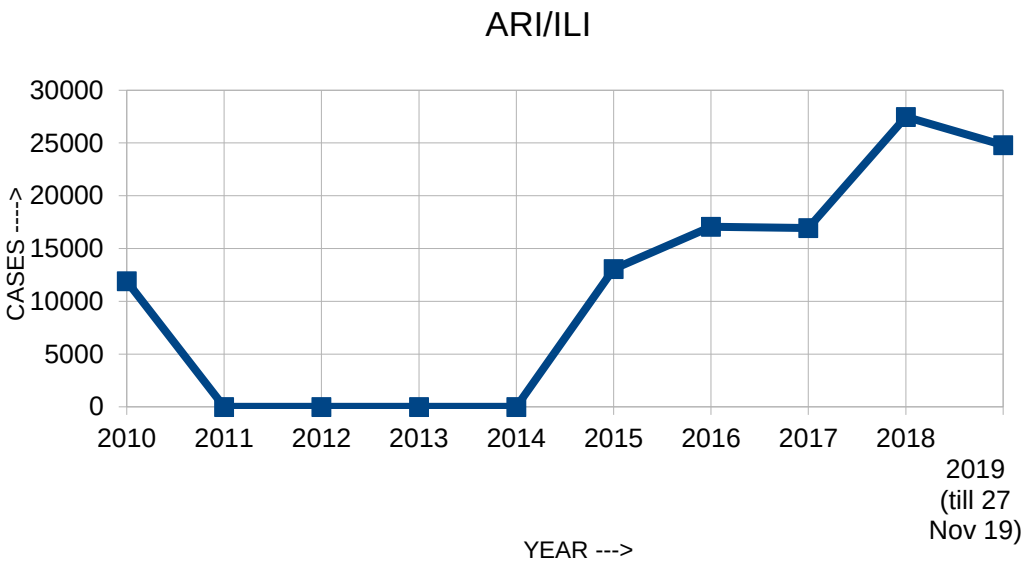
Table 27: Cases of other diseases

Year	Acute Diarrheal Disease	Acute Respiratory Infection/ Influenza Like Illness	Pneumonia
2009	14862	54779	690

[18] Goa at a glance 2017-18

2010	11923	54052	763
2011	NA	NA	NA
2012	NA	NA	NA
2013	NA	NA	NA
2014	NA	NA	NA
2015	13068	75752	890
2016	17072	74458	1156
2017	16932	73465	812
2018	27482	120878	2745
2019 (till 27 Nov 19)	24814	121035	2176

Kyasanur Forest Disease (KFD) is a tick-borne disease, which was confined to Karnataka State for more than 50 years. In the year 2015, an outbreak of fever along with vomiting & diarrhoea was reported from Pali Village of Sattari Taluka. On investigation of this outbreak, it was confirmed to be KFD. This was the first incidence of KFD in Goa. Since then KFD is reported every year from December to May. It cannot be confirmed if the disease outbreak in Goa is due to climate change or not, however, it is predicted that such new diseases or increase in cases of a certain type of diseases may increase due to climate change.



Over and above the existing medical infrastructure, Goa has launched Deen Dayal Swasthya Yojana in 2016. It is a universal insurance scheme providing insurance cover to the entire population. Also, under the Goa Mediclaim scheme, financial assistance is provided to every permanent resident of the State availing super specialty treatment that is not available in the Government Hospitals in the State of Goa. The Goa State Illness Assistance Society scheme provides financial assistance to the extent of INR 1.50 lakhs per

patient below the poverty line for availing super specialty treatment which is not available in the State Government Hospitals[19].

Impact of climate change

The health of human populations is sensitive to shifts in weather patterns and other aspects of climate change. Increased variability in the weather pattern will further impact the ability of the human body to adjust. Based on the climate change projections it is expected that:

1. The temperature in Goa may rise by 4-5 degrees and beyond a decade state may experience heatwave conditions as well which are currently not experienced in the state. This can cause health effects like dehydration, heatstroke, etc. which are known to be occurring in other states during heatwave conditions.
2. Mortality and morbidity rate due to mudslides, flooding, cyclonic events are also likely to rise.
3. Changing weather pattern is likely to increase the window for the occurrence of vector-borne disease
4. It is predicted that climate change can disrupt the health services related infrastructure and its capacity to serve due to severe events and rise in the number of illnesses
5. New diseases can be introduced in the state

Alignment with National Mission and SDG

National action plan on health and climate change has been launched in 2019 under the national health mission to address health issues related to climate change. Goa is already aligning itself for participating in the programme. In addition, Integrated Disease Surveillance Programme has been identified under Environment Health Cell for NPCCHH.

It is also aligned to SDG3 i.e. Ensure healthy lives and promote wellbeing for all at all ages. Under this the strategies are specifically focused towards the target 3.3, i.e. By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.

[19] Goa economic survey 2017-18

Adaptation strategies for health

Sr No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance	Timeframe
1	Prepare an action plan to reduce the climate change related health impacts	proposed	PHE		Others	Own budget and Central Government Contribution	1 year
2	Develop an IT enabled system to inform the public on possible and actual disease outbreak	proposed	PHE		Activity	Existing Department Budget	6 months
3	3 Study and map new and emerging diseases in the state in relation to climate change	proposed	PHE		Activity	Own budget and Central Government Contribution	continuous system
4	Prepare a heat wave action plan	proposed	PHE		Others	Unknown	6-10 years
5	Develop a system to predict disease outbreak	proposed	PHE		Activity	Own budget and Multilateral agency	

Sr No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance	Timeframe
6	Assess the adequacy and resilience of health infrastructure to climate change	proposed	PHE		Activity	Existing Department Budget	
7	Strengthen the health infrastructure based on the assessment	proposed	PHE		Activity		
8	Enhancing the knowledge skills of health workers	to be modified	PHE		Activity	Own budget and Central Government Contribution	1 year
9	Managing and dealing with pandemics – IEC and other aspects of management						

Note: The Concerned Department is expected to carry out GAP analysis and ascertain budgetary provisions and implications for the activities mentioned above and add more activities relevant to climate change within the period of atleast three months.

Approximate financial implications of health sector expected to be met from climate change plan for ten years are approximately ₹ 10 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.

7.7. Habitat

It has been predicted that by 2050 more than two-third of the world population will be living in cities. As per 2011 census, about 62% of Goa's population lives in urban areas comprising of 14 municipalities and 56 census towns. The annual tourist population of Goa is 3 to 4 times the state population, consistently putting pressure on the human habitat and natural resources of the state. The percentage of urban population has been increasing in the state. Goa has an average population density of 394 persons per sq.km. which is higher than the national average of 382 persons/sq.km[20].

For effective planning of limited land resources and increasing pressure on the resource - "Regional plan for Goa 2021" was developed by the town and country planning board. The RPG 2021 report, states that by 2021, the population projection for Goa is estimated at 18.07 lakh with nearly 13.11 lakh living in urban areas spread over 72 census towns and 14 cities. Of this population, it is estimated that 12.36 lakh will be staying in four coastal talukas of Bardez, Tiswadi, Mormugao, and Salcete, with the urban areas in these talukas accounting for 80.51 % of the population. These are the most urban talukas of Goa and economic activities including tourism-related development are concentrated in these talukas.

To be able to effectively meet the requirements of a growing population and economic activity in these talukas it is essential to not only prepare effective land use plan but also to provide and maintain:

1. Water and Sanitation Services
2. Transportation services
3. Solid waste management
4. Energy demand
5. Health services and health management

Sanitation Services: Presently the Sewerage coverage is of about 16 % in state of Goa with respect to 28% National Average. The major cities i.e. Panaji, Vasco and Margao (with population more then 50000) area already connected to the sewerage network. Sewerage system in Navelim, colva, Ponda, Mapusa, Calangute Baga , Porvorim are in progress.

The total installed capacity 78.48 MLD at present against which 25 MLD is received at STP. In addition to this, 73.50 MLD cumulative capacity STP's are in progress for completion by FY21. As of FY 2019-20, urban & rural areas combined in the state generate 388 MLD of wastewater out of which 7 % is treated through the sewerage treatment plant.

Septage treatment is more prevalent in Goa. On call service is available for septage management. Collected septage is treated in nearby STPs. Future outlook of the state is to achieve total sanitation and zero discharge of wastewater into the environment.

Most of the sewerage treatment plants are based on SBR technology and maintain the effluent standards as per Goa State pollution control boards guidelines. Details of sewerage and septage management projects is provided as annexure IV.

[20] Socio economic survey 2017-18

Sewerage at a Glance		
State Sewerage Coverage	-	16%
Sewerage Generation	-	388 MLD
Total installed Capacity in MLD (Designed)	-	78.48 MLD (8 major STP's)
Treatment Done in MLD (present)	-	24.73 MLD
Total Capacity in MLD in progress	-	73.50 MLD (8 major STP's)
DPR's prepared	-	Rs. 3078.59 Cr
Additional Coverage of balance areas	-	Rs. 1660.00 Cr
Time Frame Required for Sewerage Scheme-Funds)		5-10 Years (As per availability of

Storm Water Drains: All the Village Panchayats are part of the Disaster Management Plan for the State of Goa. They make their Disaster Management Plan and submit the same to the Taluka Mamlatdar. As a precautionary measure and in order to avoid likely constraints to be faced due to climate change, all the Village Panchayats regularly undertakes Works of cleaning drains, repairs and maintenance of these drains.

Creation of Technical Cell and Green Cell: the establishment of independent Technical Cell for Directorate of Panchayats is in process which will help in expediting civil works of Village Panchayats and which will also help monitor construction with sustainable development such as use of solar panels, rain water harvesting etc. For setting up of Solar Panels for each and every Panchayat Ghar the Directorate of Panchayats require funds of Six Crores for the 191 Village Panchayats located across the State of Goa.

Schemes, Initiatives, and Policies

- The city of Panaji has a city sanitation plan
- Regional land use plans up to 2021
- Affordable housing: In RPG 2021 pockets of settlement areas aimed at providing low-cost housing, industrial/migrant workers housing, 20-point program housing, etc. are accordingly designated in the surface utilization plans. These areas shall be taken for development by either the agencies of the government-mandated to take up such schemes, or by the owners of such lands – collectively or individually depending on whether the land is owned by individuals or by communities. This is aimed at addressing the current gap that exists in the supply vs. demand for affordable housing.
- JICA funding for the sewage treatment plant
- As per the Outline plan of major cities solid waste management site has been identified in the cities of Panaji, Vasco-da-Gama, etc.

- Laying of sewer network for balance and low laying areas is proposed at an expenditure of approximately Rs. 1660Cr.
- Sewerage Act and Policy for Mandatory House Sewer Connections

Impact of climate change

While the state has developed a regional land use plan, climate change can make all plans and infrastructure ineffective if they cannot stand the climatic change impact and exposure.

As per the climate change predictions, provided in an earlier chapter, the taluka's of Bardez, Tiswadi and Salcete are most vulnerable to flooding and sea-level rise (Appendix). Also as indicated earlier the taluka of Marmugao is vulnerable due to high population density and the presence of 90% of Goa's slum population.

Extreme Precipitation Events: Such events are predicted to rise and can render the service infrastructure in these areas unusable during disasters. It can as well affect the infrastructure resulting in financial loss.

Increased temperature: Temperature is predicted to rise significantly and the duration of high and low-temperature days is expected to change. Increasing urbanization and building infrastructure is adding to the need for cooling systems like loss of Khazan lands due to climate change and ingress of water up to 40kn along the rivers has been predicted.

7.7.1 Synergy with National Mission and SDG

The national mission on sustainable habitat, is a mission under the NAPCC which seeks to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste including recycling and power generation, modal shift towards public transport and conservation. It also seeks to improve ability of habitats to adapt to climate change by improving resilience of infrastructure, community-based disaster management and measures for improving advance warning systems for extreme weather events.

The mission requires action based on:

(a) development of sustainable habitat standards that lead to robust development strategies while simultaneously address climate change

(b) preparation of city development plans that comprehensively address adaptation and mitigation concerns

(d) capacity building for undertaking activities relevant to the Mission

The sustainable development goal no. 11 (SDG11) call s for sustainable cities and communities. It has below mentioned targets and these targets are partially or fully meet by the adaptation strategies as applicable:

- By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
- By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
- By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
- Strengthen efforts to protect and safeguard the world's cultural and natural heritage
- By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
- By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities
- Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning
- By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels
- Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

Strategies for adaptation

Since the talukas of Bardez, Tiswadi, Mormugao, and Salcete contain most of the state population, economic activity and are at the highest risk due to climate change, adaptation will be prioritized for these talukas. Hence, these talukas are prioritized for

1. Climate based infrastructure vulnerability assessment of critical services
2. Development of a plan for the resilience of vulnerable structure associated with critical services
3. Redesigning the regional land use planning maps of most vulnerable areas after considering climatic factors
4. Identifying measures like creating flood control gates etc. for controlling flooding events due to various aspects like the upward flow of water into the rivers
5. Development of climate-based disaster management plan
6. Implementation of a solid waste management plan
7. Enhancing internal waterways for transportation

8. Strategy to relocated/compensate and identify new means or alternate skill for the owners of khazan lands as the probability of submergence due to climate change increases
9. Identify and explore natural mechanisms like increased mangroves or sea walls etc to guard against sea-level rise.

Table 28: Adaptation Strategy for Most Vulnerable

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance
1	Study on Climatic resilience of Marmugao and development of action plan	proposed	Climate change cell/department/secretariat		Others	NAFCC
2	Implementation of climate resilience action plan for Marmugao	proposed			Activity	Own budget and Multilateral agency
3	Climatic resilience plan for Salcete, Tiswadi, and Bardez should be developed	proposed	Climate change cell/department/secretariat		Others	NAFCC
4	Implementation of climate resilience plan for Salcete, Tiswadi and Bardez	proposed			Activity	Own budget and Multilateral agency
5	Gender vulnerability action plan	proposed			Awareness raising and capacity building	
6	Alternate skill development plan for vulnerable population	proposed			Awareness raising and capacity building	
7	Alternate skill development and facilitation as per the plan	proposed			Activity	
8	Development of last Mile Connectivity and Early Dissemination Solution for the State under NCRMP-II.	under progress			Activity	

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance
9	Multipurpose Cyclone Shelter (MPCS) & MPCS with fire stations are proposed to be taken in Canacona, Mormugao, Bardez, Pernem and Tiswadi Talukas.	under progress			Activity	

Table 29: Adaptation Strategies for Habitats

Sr. No.	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance	Time frame
1	Climate resilient city sanitation plans are developed or existing plans are strengthened to be climate resilient	to be modified	TCP		Policy	Existing Department Budget	
2	Service level benchmarks should be met in all major towns and cities	under progress	TCP		Others	Existing Department Budget	
3	To carry out the preparedness assessment of low-lying areas in the four taluks to flooding and other climatic stresses which can cause flooding						

Sr. No.	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance	Time frame
4	Implement measures to make these areas ready for climatic stresses	proposed					
5	Khazan lands protection from climate change	to be modified					1-2 years
6	Sea protection walls or natural pathways to guard against sea level rise must be identified and deployed	proposed		Cost could be prohibitive and effectiveness needs to be assessed	Activity	Multilateral agency	6 to 9 years
7	Making provision at sea and river confluence to back water or tidal water into the rivers	proposed		Cost could be prohibitive and options could be limited	Activity		2-3 years
8	Identifying vulnerable khazan land owners, providing alternate skills and livelihood options for future	proposed	TCP and agriculture department		Scheme	Existing Department Budget	1-2 years
9.	Online Management of Sewerage Infrastructure with implementation of GIS based mapping.	underway		GIS based mapping for Panaji, Vasco and Margao sewerage system has been completed. As other areas get covered		Existing department budget	

Sr. No.	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance	Time frame
				this will be applied to them as well.			
10	Introduction of village carrying capacity concept in any developments/development projects in each village	Proposed	Panchayat Raj department		Policy	-	-
11	Material recovery facility at Village level	Proposed	Panchayat Raj department	Only villages with land can implement it	Infrastructure	XXX	XXX
12	Developing climate resilient and low cost housing	Proposed	RDA				

Note: ***Approximate financial implications of transport sector expected to be met from climate change plan for ten years are approximately ₹ 10 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.***

GIS based mapping of the sewer lines of Panaji, Vasco and Margao Sewerage system has already been done. Since Sewerage schemes in Navelim, Colva, Ponda, Mapusa (Part), Calangute, Baga are in progress mapping of same is not done. Once the schemes are completed mapping will be done in due course of time.

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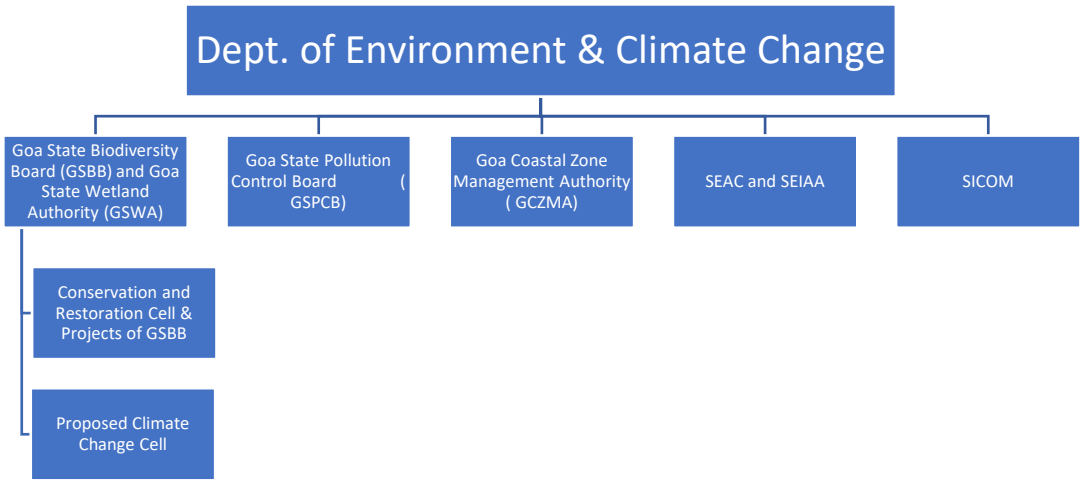
https://tcp.goa.gov.in/wp-content/uploads/2016/gazette/RPG21_Bardez_Tiswadi_Mormugao_Salcete_Notification.pdf

Department of Environment & Climate Change – Govt. of Goa



Department of Environment & Climate Change – Significant actions initiated and proposed in the context of climate change.

a. Setting up climate change cell under Dept. of Environment to function as secretariat.
b. Mapping of perennial springs and assessment of water quality of perennial springs and ground water,
c. water quality assessment of lakes and ponds and restoration of water quality through interventions
d. GIS mapping of eco sensitive areas, forest, bunds , sluice gates, aquaculture ponds, water and air quality monitoring stations of GSPCB sacred groves (devrai), springs, lakes, ponds, water bodies and creating environment quality data.
e. De-centralized sewage treatment plants at Agonda, Palolem, Morjim and Mandrem.
f. Study on *khazan* and it's ecosystem services.
g. Salinity mapping in ground water.
h. Ozone / UV treatment facility to existing STP of PWD/ JICA/SIDCGL.
i. Restoration of bunds and sluice gates

Goa State Biodiversity Board

Unique Initiatives by Goa State Biodiversity Board by involving the network of Biodiversity Management Committees (BMCs0 constituted at ground level in every local body

Goa State Biodiversity Board has always strived to ensure maximum participatory approach at grassroots level and so far, awareness programs on need for biodiversity conservation and mainstreaming biodiversity" have been conducted at all levels throughout the State of Goa.

Highlights of important initiatives worth replicating in other areas

1. Roadside selling farmers were provided platform to sell their produce in air-conditioned mall to as part of celebration of International Day for Biodiversity in 2019 with theme "Our Biodiversity, Our Food, Our Health". Surprisingly they earned over ₹ 60,000/- within half day and over ₹1.5 lac worth recurring orders for further period due to contacts developed.

2. Special project is taken in the State on Conservation of biodiversity through livelihood interventions wherein local farmers, horticultural and minor forest produce will be subjected to value addition at clusters of villages and market linkages will be provided to increase earning of Bioresources owners - locals. This will encourage them to conserve and multiply plantations of various landraces of plants, fisheries and also other shellfish ultimately leading to ecosystem conservation through beneficial mechanism. There is plan to promote GoVan brand wherein locals will be empowered through network of GoVan (also means go back to forests and nature)

3. People's Biodiversity Registers are prepared with participation of villages especially elders and youngsters wherein not only biodiversity is documented but validation is participatory at three levels BMC level, Gramsabha level and State level. Hence village gets honored when they get opportunity to present their village biodiversity registers to eminent intellects at State level. They also become emotional when they themselves learn about their village awhile documenting the vast Bioresources and associated knowledge which was so far confined to certain families or never given importance. Outcome of PBR is used for deriving conservation focus and prioritization of issues at village level. This has created micro level green revolution in villages. Certain examples are – revival of famous and unique watermelon variety of Parra Village (native village of Former Defence Minister of India/ Former CM and Chairperson of Goa State Biodiversity Board Shri. Manoharbhai Parrikar – his surname comes from this village name). This variety was almost extinct and only two women in village had preserved handful of seeds (this emphasizes role and contribution of women in biodiversity conservation). GSBB took initiatives and revived this variety by multiplying seeds. In another initiative archiving of Medicinal plants document/ Book in Urdu from Curti Khandepar BMC area was possible due to PBR exercise.

4. Uniqueness of our PBR process is that technical support groups are not only eminent institutions or ecologically expert companies but also local farmers self help groups with necessary qualification and expertise have ben empanelled with GSBB as technical support groups who guide villages in preparation of PBRs.

5. Our next initiative is green skilling wherein employment opportunities will be created for aspiring youth in practicing traditional occupations such as – revival of traditional Knowledge based techniques, systems and practices such as Bundhs and Sluice gates. Making of watershed structures and walls with use of naturally occurring material including reinforcement by mangrove wood or bamboos.

6. State level Biodiversity Awards are conferred upon the individuals as well as BMC level to encourage the conservation efforts in biodiversity conservation.

7. While signing Access Benefit Sharing (ABS) Agreements, first time agreement is signed without cash but "in-kind type" wherein signatory will conduct awareness and capacity building amongst villagers rather than paying to GSBB.

8. Television series of 20 parts on biodiversity of Goa *'Bhowandi Jaivik Fudarachi'* on Goa Doordarshan Channel featuring unique biodiversity of Goa

9. Periodic public lecture series by eminent personalities in the fields related to biodiversity. Collaborative programs for Youth - Youth Festival – *Yuva Jagruti* and TEDx event wherein over 600 students participate in various competitions at State level.

10. Conservation and Restoration Cell established at GSBB. GSBB has documented and published the book 'Tradable Bio-resources of Goa' and has published book on the prominent Sacred Groves of Goa.

11. Goa State Biodiversity Board notified the Goa State's first Biodiversity Heritage Site – 'Purvatali Rai' of Surla Village, Bicholim Goa.

12. Legal Advisory Group headed by Retd. Justice, involving legal aid cells of law college students for handholding BMCs. Suo moto cognizance of Biodiversity related issues in many matters such as conservation of habitats of rare varieties of the windowpane oysters and other unique local varieties.

13. The Curtorim Biodiversity Management Committee (BMC) & Farmers of Curtorim have launched a 100% locally grown rice under the name "CUDDTARI" - an initiative supported by GSBB. Based on this and such other experiences related to livelihood, a project on achieving conservation through livelihood interventions is taken up by GSBB. This will benefit locals and also lead to biodiversity conservation.

Network of BMCs is activated from time to time for important activities such as identification and ground truthing of Bunds, khazan land management etc. This is directly related to climate change intervention for low lying areas.

Another example is that even during covid 19 pandemic lock down period, GSBB utilized network of BMCs to identify local homemaker who know tailoring and were involved in stitching over 25000 facemasks which were further supplied to Govt departments. This is example of going beyond mandate during crisis times. MS GSBB is member of State economic advisory to find remedies for dealing with impacts of covid 19 pandemic and revival of economy.

Other initiatives planned are below

- Seed Bank for the State of Goa is planned to be established.
- First in India Sand dune Park will be created through "ICZMP – World Bank".
- Sand mining impact and river Biodiversity Index study and Wetland identification are ongoing through Department of Environment.

Goa State Biodiversity Board (GSBB) – Nodal Agency for Goa State Wetland Authority – (GSWA)} – Goa State Biodiversity Board is an autonomous body of Govt. of Goa, under the umbrella of Dept. of Environment is line Dept.

This board has also created conservation and restoration cell to take up the tasks of preparation

Government of Goa approved 03 ICZMP- Projects to be implemented in the State of Goa:

1. **Establishing and designating coastal sand dune parks in Goa.**
   a. North Goa
      i) Tiswadi Taluka: Miramar
      ii) Pernem Taluka: Mandrem- Morjim Belt
   b. South Goa
      i) Canacona Taluka: Galjibag – Agonda Belt
      ii) Salcete Taluka: Colva- Cavelossim Belt

2. **Erosion/ accretion- Assessment studies to ascertain feasibility of annual replenishment of sand along the estuarine stretches identified for Goan Estuaries.**

3. **Study of critical coastal habitats from the context of biodiversity conservation.**

<u>Inputs for SAPCC</u>

2. **Goa State Pollution Control Board (GSPCB)**

a. Installation of online real time monitoring station at Panaji , Mapusa, Margao, bicholim, and Amona, along with noise monitoring station.

b. Real-time online portable air quality monitoring station with scatter light technology In mining areas
c. Online water quality monitoring station in Mandovi, Zuari, Chapora river and on coast at Palolem, Colva, Calangute and Mandrem beaches.

Goa State Wetland Authority (GSWA)

a. Wetlands shall be Identified and Notified in the State of Goa.
b. Wetland Mitra belonging to the local community will be appointed for the Notified Wetlands in the State of Goa
c. Community and BMC driven Restoration and reclamation of water bodies for future water security will be undertaken by part voluntary labor from the locals.
d. Complete Biodiversity (Flora, Fauna and Microbial level) assessment of available resources of wetland ecosystem will be undertaken in project mode by involving research based organization, institutes and colleges for finding solutions to water crisis and abetment.
e. Community driven conservation and management of Wetlands through livelihood projects will be undertaken, with efficient and wise use of the wetlands ecosystem resources.
f. Revival of traditional practices (introduction of lost indigenous fish species encouraging further fishing, use of Sluice gates to regulate the water contained and its use in traditional practices such as paddy cultivation in low-lying regions, which do not cause any adverse effects to the ecological character of the respective wetlands) will be undertaken
g. Awareness programs for conservation and management of Inland fresh water reservoirs will be undertaken.
h. Use and role of urban wetlands/lakes in the State of Goa for (a) reduction of ambient temperature and avoiding urban heat islands and (b) acting as carbon sink for GHG emission will be carried out as climate change mitigation measure.

Financial Implications

Sr. No.	Name of the Dept. / Agency / Board / Authority	Intervention	Financial Implications in – Lacs ₹					
			Duration	**State Govt**	**Others - *GMR / World Bank**	**Central Govt**	**Gap fund required from Climate Change Sources**	**Total ₹ lacs**
1	Goa State Biodiversity Board	Study of sand mining impact, accretion and river biodiversity index – already initiated and ongoing through State funding	2 years	20%	50% World bank	30%	-----	900.00
2	Goa State Biodiversity Board	Sand Dune Park in Goa for conservation, restoration and understanding of sand dune ecosystem	3 years	20%	50% World bank	30%	--------	310.00
3	Goa State Biodiversity Board	Study of critical coastal habitats	3 years	20%	50% World bank	30%	-----	55.00
4	Goa State Wetland Authority	Wetland Identification & Related technical assistance through NIO	2 years	100%	-----	-----	-----	175.00
5	Goa State Biodiversity Board	Compensatory afforestation for Mopa Airport. State may contribute more over period of next 10 years	5 years for planting 5 lac trees	50 lacs	*100 lacs	---	-----	150.00

6	Goa State Biodiversity Board & Wetlands	Restoration and Conservation programs specific to climate change in the State for vulnerable areas such as developing sustainable working models for sustainable restoration and management of riparian ecosystems and other areas with interventions such as climate resilient varieties of rice - rice park, erosion control measures, mangrove related interventions, livestock & related interventions, etc. will be made to establish two models in two districts of Goa in collaboration with Dept of Agriculture and voluntary organization	10 years	10 lacs	---	---	**230**	**910.00**

7	Goa State Biodiversity Board	Creating seed bank for germplasm preservation, propagation and promotion for conservation, livelihood and climate change	3 years	60 lacs	-----	30lacs (Through NABARD or Central Schemes)	**210**	**300.00**
8	Goa State Biodiversity Board	Conservation programs at BMC level in every village based on conservation focus derived from PBRs @₹ 10 lacs per local body for 205 local bodies	10 years	205 lacs	----	----	2050	
9	Goa State Biodiversity Board	Setting up climate change cell under GSBB to function as secretariat.	10 years	10 lacs	-----	100 lacs	10	**110.00**
10	Dept. of Environment	Restoration of bunds, sluice gates and strengthening coastal & riverine protection systems	10 years	1000	-----	-----	3000	4000.00
11	Dept. of Environment	Mapping of perennial springs and assessment of water quality of perennial springs and ground water	10 years					
12	Dept. of Environment	water quality assessment of lakes and ponds and restoration of water quality	10 years	50			150	200.00

		through interventions						
13	Dept. of Environment	GIS mapping of eco sensitive areas, forest, bunds , sluice gates, aquaculture ponds, water and air quality monitoring stations of GSPCB sacred groves (devrai), springs, lakes, ponds, water bodies and creating environment quality data.	10 years	50			150	200.00
14	Dept. of Environment	De-centralized sewage treatment plants at Agonda, Palolem, Morjim and Mandrem.	10 years	50			375	425.00
15	Dept. of Environment	Study on *khazan* and it's ecosystem services.	10 years	50			150	225.00
16	Dept. of Environment	Salinity mapping in ground water.	10 years	50			150	225.00
17	Dept. of Environment	Ozone / UV treatment facility to existing STP of PWD/ JICA/SIDCGL.	10 years	50			400	450.00
19	Dept. of Environment	Environment conservation related	10 years	50			100	150.00

		interventions by schemes						
20	Goa State Pollution Control Board (GSPCB)	Installation of online real time monitoring station at Panaji , Mapusa, Margao, bicholim, and Amona, along with noise monitoring station.	10 years	10			50	60.00
21	Goa State Pollution Control Board (GSPCB)	Real-time online portable air quality monitoring station with scatter light technology in mining areas	10 years	25			75	100.00
22	Goa State Pollution Control Board (GSPCB	Online water quality monitoring station in Mandovi, Zuari, Chapora river and on coast at Palolem, Colva, Calangute and Mandrem beaches.	10 years	100			400	500.00
						Total	**7500**	**9445.00**

8. Climate Disaster Management with special reference to climate migrants and refugees

Disasters are caused due to natural or man-made hazard situations. The impact of a disaster varies from reversible to irreversible and in many cases the impacts lie somewhere in between. As per the Disaster Management Act, 2005, disaster is defined as 'a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property or damage to, or degradation of environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected areas'.

Climate change has across the world, enhanced the occurrence of disaster events both in depth and breadth. One of the consequences, of climate change related disasters is migration of people within the country or from another country leading to climate migrant's and refugees. These migrations could be permanent or temporary. IPCC has indicted that the climate change could lead to largest movement of human population leading to migration within and beyond the country borders. According to the Internal Displacement Monitoring Centre reports, 18.8 million new disaster-related internal displacements were recorded in 2017. It has found that most disaster displacements are linked to natural hazards and the impacts of climate change is internal, with those affected remaining within their national borders. However, displacement across borders also occurs, and may be interrelated with situations of conflict or violence.

India has a long, densely populated low-lying coastline, young Himalayan system and vast arid region. Due to the diversity and complimenting factors, internal migration is already experienced in India. Season migration is a common phenomenon experienced in several parts of the country. Labour migration has been permanent in several places. Refugees along the country's borders are more prominent in the border regions of the country, for example: migrants and refugees from neighbouring Bangladesh. Climate change is expected to increase this phenomenon.

Status of migration and refugees in Goa

Currently Goa experiences migration of people from different parts of the country like Telangana, Andhra Pradesh, Orissa, Bihar etc as migrant workers. Migrant workers mostly find place as agricultural labourers and in tourism industry. Goa does not share land border with any of India's neighbouring countries and has not faced any significant refugees so far.

Expected impact of climate change

Climate change as indicated in earlier sections of the report has a likelihood of resulting in:

1. The loss of Khazan lands which may lead to migration of khazan land owners and their families
2. Inundation of several portions of taluks like Salcete, Bardez, and Tiswadi causing people to evacuate these areas

These scenarios may in the longer time frame, lead to permanent migration of population within Goa to areas with higher altitudes. Apart from these, recurrent disasters may create a greater number of temporary or seasonal migrants within Goa as well.

Women, marginalized population and children are considered to be more vulnerable and have different needs as migrants and refugees. The current disaster management practices often fall short in addressing these needs.

National Cyclone Risk Mitigation Project (NCRMP), a World Bank funded project in India focuses exclusively on ex-ante disaster risk mitigation. It is implemented by the National Disaster Management Authority (NDMA), New Delhi with the support from Ministry of Home Affairs (MHA), GOI focusing on the cyclone prone coastal States and union territories. In the phase II, the States of Gujarat, Maharashtra, Kerala, West Bengal, Karnataka and Goa have been included. Following activities are being taken up under the project:

1. DPR for Development of last Mile Connectivity and Early Dissemination Solution for the State under NCRMP-II.
2. Multipurpose Cyclone Shelter (MPCS) & MPCS with fire stations at Canacona, Mormugao, Bardez, Pernem and Tiswadi Talukas.
3. Awareness on Disaster preparedness programme 2017-18 was conducted by the NDRF team in all the 7 talukas of south Goa.

Issues arising from Migration and refugee

Migration can increase health issues and health cost burden for the state. As an example: 2,72,236 patients were tested for malaria and 543 patients were found to be positive. 267 locals have been affected by malaria and 37 by plasmodium Falciparum. 50.83% cases were reported among migrant population at the construction sites.[21]

Some of the other challenges arising from seasonal migration and refugees are rights and social entitlements, lack of formal residency or residency rights, lack of identity proof, lack of political representation, low-pay work, insecure or hazardous work and extreme vulnerability of women and children.

It could also lead to additional stress on civic infrastructure, stress on limited land resource available with the state, food security issues and further exploitation of the ecologically fragile western ghats.

Women have special needs when staying in shelters and camps. These needs are often missed out in the regular shelters.

UNICEF[22] has identified that migration delays school entry, denies or interrupts schooling, increases the number of children dropping out and leads to child labour.

Adaptation plan to address the challenge

Two level approach and strategy are proposed for managing migration and refugee issue in Goa:

1. **Systematic movement and settlement of migratory population** whose current habitat and/or livelihood is under danger from climate threat despite enacting habitat

[21] Socio economic survey 2017-18

[22] Internal migration in India initiative, for better inclusion of internal migrants in India

adaptation measures (suggested in chapter 7). This should assist in reducing the risk of lives, property and systematic adjustment to alternate livelihood options

2. **Re-settlement of post disaster refugees in a gender sensitive manner**

An action plan on identification of alternate skills and livelihood for vulnerable population has been provided in chapter 7.

The other adaptation measures to be considered for migrants and refugees:

1. Development of gender sensitive post disaster relief policy
2. Development of a coherent legal and policy framework for migrants and refugees
3. Development programmes should be designed keeping in mind the local disaster threats and disaster reduction should be an integral part of the development programmes
4. Develop a minimum social security system for post disaster migrants and refuges
5. Identify and ear mark areas and structures for resettlement of those under threat of subsidence
6. Set up a process for counselling the people who are to be re-located over the years and those who get relocated involuntarily due to disaster.
7. Engage refugee women in a dialogue and in social activities
8. Develop child focused rehabilitation plan

Sr. No	**Intervention**	**Status**	**Responsible agency**	**Barriers and Gap in implementation**	**Intervention Type**	**Source of Finance**	**Timeframe**
1	Development of gender sensitive post disaster relief policy	proposed	Disaster Management Authority		Policy	Existing Department Budget	1-2 years
2	Development of a coherent legal and policy framework for migrants and refugees	proposed	Disaster Management Authority and Revenue Department		Policy	Existing Department Budget	3-5 years
3	Development programmes should be designed keeping in mind the local disaster threats and disaster reduction should be an integral part of the development programmes	proposed			Others	Own budget and Central Government Contribution	3-5 years

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance	Timeframe
4	Develop a minimum social security system for post disaster migrants and refuges	proposed			Others	Unknown	1-3 years
5	Identify and ear mark areas and structures for resettlement of those under threat of subsidence	proposed	Revenue department			Existing Department Budget	3-5 years
6	Set up a process for counselling the people who are to be re-located over the years and those who get relocated involuntarily due to disaster.	proposed	Disaster management authority		Activity	Own budget and Multilateral agency	5-7 years
7	Engage refugee women in a dialogue and in social activities	proposed	Child and Women Welfare Department along with Disaster Management authority'		Activity	Own budget and Multilateral agency	
8	Develop child focused rehabilitation plan	proposed	Child and Women Welfare Department along with Disaster Management authority'		Others	Existing Department Budget	1-2 years
9	Formulation and implementation of stricter CRZ rules for new development in areas sensitive to subsidence	proposed	Urban development bodies		Scheme	Existing Department Budget	1-2 years

Sr. No	Intervention	Status	Responsible agency	Barriers and Gap in implementation	Intervention Type	Source of Finance	Timeframe
10	Sensitization, Awareness and capacity building among various departments on the topic of migrants and refugees as a result of climate change	proposed	Climate change secretariat		Awareness raising and capacity building	Multilateral agency	1-3years

Note: The Concerned Department is expected to carry out GAP analysis and ascertain budgetary provisions and implications for the activities mentioned above and add more activities relevant to climate change within the period of atleast six months. Approximate financial implications of disaster management sector expected to be met from climate change plan for ten years are approximately ₹ 10 crores. Detailed plan for expenditure along with gap analysis will be prepared by the department within 6 months.

9. Financing of Climate Action Plan

In 10 years, from 2006 to 2015, infrastructure and other asset losses in the Asia and Pacific region resulting from floods, earthquakes, and tropical cyclones averaged $73 billion yearly (56% of the global total) and $199 million per day. ADB's disaster risk models indicate an average annual loss over the long-term equivalent to more than 2% of gross domestic product (GDP) for 11 Developing member countries (DMCs), and over 1% of GDP for 21 DMCs[23]. 431 major natural disasters have occurred in India in 30 years period from 1980 to 2010, resulting in a huge loss of human lives, property, and resources. Natural disasters between 1998-2017 have resulted in an absolute financial loss of US$79.5 billion [24]. Similarly, a single extreme weather event in Goa, on 2nd of October 2019, in Canacona taluk resulted in loss of over INR 100 crore[25]. Many of these events and the nature of these natural events are attributed to climate change. It is predicted that the severity and frequency of these climatic events will increase due to climate change and inaction will lead to huge economic losses in the future.

ADB has predicted that inaction in some of the southeast Asian countries could result in a loss equivalent to more than 6% of GDP while adaptation at a cost of just 0.2% of GDP for investment in such things as seawalls and drought- and heat-resistant crops, could avoid damages amounting to 1.9% of GDP, on an annual basis. (Climate Change Operational Framework 2017–2030, Asian Development Bank). Thus, factoring climate action into the future of Goa and climate-proofing Goa and its investments can be expected to contribute towards the State's economic progress as well.

[23] Climate Change Operational Framework 2017–2030, Asian Development Bank
[24] India's second communication to UNFCCC
[25] Report of the Canacona Flash Floods Study Committee constituted by the Government of Goa

The total budget required for implementing the SAPCC in Goa has been projected to be INR ₹ Rs 465.00 Crores for ten years, which works out to be ₹ 46.5 Per Annum and amounts to approximately 0.22% of Annual Budget and 0.050 % of Gross State Domestic Production (GSDP) of Goa State. The same may get revised or updated over the years, based on any additions or modifications to the SAPCC. One of the steps for mainstreaming climate change is to factor the above-identified amount annually into the state budget.

As per UNFCCC, Climate Finance refers to local, national or transnational financing—drawn from public, private and alternative sources of financing—that seeks to support mitigation and adaptation actions that will address climate change.

In light of the above, climate finance needed for the state should be sourced from a set of best suitable options. It is expected that the state budget would be the key contributor to the climate change budget for the state. Besides, SAPCC will also leverage on national programs, policy, schemes, convergence with national programs and funds, multilateral and bilateral agency funding, market-based mechanisms/instruments and other climate finance options.

Following is an indicative structure to adopted by Goa for financing the measures under SAPCC

- Allocation of dedicated budget for climate-related policy development, awareness and capacity building
- Identified projects which are adaptation based and need additional financial resources which are beyond the capacity of the state to absorb and are below INR 25 crore in value or require co-finance which is within INR 25 crore and pilot in nature can apply for NAFCC funding
- Projects which are large, replicable and essential for climate mitigation or adaptation but beyond states ability to finance in totality and do not have converge with any other scheme or certain components do not have any source of funding can attempt multi-lateral development agencies or other climate funds like GCF funding
- For other activities which are essential and regular with a possibility of a return, can be undertaken through concepts like the revolving fund, green bonds, etc.

9.1. **State internal finance**

The total budget required for implementing the SAPCC in Goa has been projected to be INR ₹ Rs 465.00 Crores for ten years, which works out to be ₹ 46.5 Per Annum and amounts to approximately 0.22% of Annual Budget which is ₹21056.35 (estimated for 2020) and 0.050 % of Gross State Domestic Production (GSDP) of Goa State which is ₹92260.53 (as per CMs budget speech). The total expenditure of the state is estimated at Rs.39640.53 crore. On the expenditure side, Social Services account for Rs. 4732.61crore i.e. 40.33% of the estimated total expenditure, followed by Economic Services at Rs.3475.38crore or (29.61%) and General Services at Rs.3528.05crore (30.06%). It has a

revenue surplus of INR 455 crore. Grant-in-aid &contribution from central government is Rs 1249.68 crore.

State departments are carrying out activities that directly or indirectly contribute towards SAPCC i.e. climate mitigation and/ or adaptation. For example, switching to LED lights in Panaji, and utilizing power generated at Saligao solid waste treatment plant. However, in the absence of any mechanism to account for expense under climate change, **the expenditure on climate change is currently unaccounted**.

Hence, there is a need to establish a mechanism to identify states' current expenses on items that contribute towards climate change and the source of current finance.

To further enhance the funding of the state on climate change, there is a need to identify own resources, market, and insurance option which can further contribute to the climate change budget of the state.

Own Resource
❑Own resources at district, town or taluk level ❑Convergency of state schemes ❑Incorporation of essential climate elements in the existing programs, schemes, projects, state policies etc will result in utilization of existing committed finance towards climate mitigation and /or adaptation ❑Setting up of annual dedicated budget for climate change

Market and Insurance
• Climate Risk insurance specifically for farm sector • Public Private Partnership • Issuance of Green Bonds (for example : Ahmedabad Municipal Corporation) • Catastrophe Bonds • Incentives for Green Initiatives and Activities by citizens, tourist and business • Establishing Revolving fund • Channelizing Corporate Social Responsibility funds

In addition, existing corporate sector in Goa spends on CSR activities. This CSR expenditure by corporate sector can be further aligned to meet the state governments requirements.

Sector as per CSR fund distribution	Interventions/actions to be incorporated
Education	• School level education programmes on climate resilient measures like maintaining agricultural spaces, promoting green buildings, importance of regulating plastic and inorganic material, etc. • FGDs, outreach programmes in schools, madrasas to develop awareness
Healthcare	• Mobilization and streamlining of rag pickers on health and hygiene issues
Skills Development	• Skill development of urban poor to work with non-biodegradable waste recycling methods – Inorganic waste to planter bags and handicrafts • Waste collection and segregation from areas with low accessibility
Environment	• Funds towards improving rate of plantation as part of Haritha Haram • Promotion of vertical gardening and farming • Restoration of water bodies and wetlands
WASH	• Installation and maintenance of dry toilets in public schools and informal settlements • Awareness building and outreach on good sanitation practices • Provision of safe drinking water in informal settlements in the vicinity of the corporate entity
Livelihood	• Organizing workshops, training modules or exposure visits on greener and cleaner technologies for concerned government staff
Women Empowerment	• Funding women SHGs to scale their operations particularly in sanitation, construction of semi-pucca houses, etc.
Others	• Designing effective communication plan for disaster response • Periodic cleaning of drains in areas prone to water logging

9.2. Revolving funds (Rf) or Circular funds for climate change

Revolving Funds (RF) or Circular Funds for climate change are pool capital funds using federal, provincial or municipal funds which can then be loaned out to finance infrastructure or other climate change projects at low-interest rates. Money is repaid into the fund which can be loaned out again. These funds are flexible in design and can use a multitude of options in terms of the collection of funds. Usually, these funds are well suited for mitigation activities like renewable energy projects but can also be utilized to tackle climate adaptation activities like water security. The differences and similarities in the design of Rfs speak volumes on the strength of the concept as a whole. The differences allow for elbow room to tailor-build the mechanism according to the country/state/municipality, while the similarities lend ideas to economies on how to maximize its utility.

A revolving fund is proposed for the State of Goa to support the application of initiative between all levels of government. A consensus needs to be reached for the efforts to fructify. The private sector can also be included in this model and a market-based system can be developed. All activities under this must also satisfy social requirements and environmental safeguards.

The next step is to develop a complete guideline for enacting the fund in the State of Goa for utilization or complementing activities which do not find regular budget in the state. The operational mechanism for this fund can be through an SPV under the state secretariat on climate change.

9.3. Green tax on tourism

Tourism is the major industrial sector in Goa. Every year, tourists visiting Goa are almost four to five times population of Goa. Eco-tax or Green tax to combat climate change is proposed to assist in mitigation and adaptation activates of the areas which are most frequently visited by the tourist. Such taxation models are under implementation in countries like Spain. The system can be developed based on the tourist's standard of accommodation.

As a next step, the institutional structure would need to be established to develop a functional model for taxation and its appropriate utilization. **Appropriate mechanism, time frame and other modalities will be worked out by tourism department.**

10. Implementation of SAPCC and Institutional Mechanism for Implementation

Implementation could involve multiple stakeholders through their projects but as decided and approved by the State level steering committee for climate change for National adaptation fund for climate change (SLSC for NAFCC), initially two model projects could be developed in Goa in two districts wherein maximum convergence of climate change related interventions could be exemplified. The project concept note in this regard has been approved. The institutional framework has been proposed as given below.

10.1. Institutional Framework for Implementation of SAPCC

An appropriate institutional framework with clearly identified roles and responsibilities is essential for the effective implementation of SAPCC. A state nodal agency on climate change will be formed in the Dept. of Environment and Climate Change for the which will serve as the climate change secretariat for the State of Goa. Secretariat will be headed by a senior government officer and will comprise of resources with a background in climate change and understanding of Goa's local context. It will be supported by experts in climate change, from within and/or outside the state. Other staff as needed for the effective functioning of the secretariat shall be identified.

The secretariat will hold the responsibility of:

1. Knowledge management - developing, managing, and updating information on climate change from state, national and global perspective, dissemination of such information to the concerned department, institute, etc on time.

2. Awareness-raising and capacity building – It will be responsible for conducting awareness programs for public and otherwise and also carrying out capacity building activities for departments and all concerned with the delivery of SAPCC. Facilitating green skill development pertaining to climate change.

3. Assisting in climate finance – Any project/ activity or intervention planned under SAPCC or proposed otherwise to be implemented partially or fully through climate finance options other than the state or department internal funds will be coordinated by the secretariat. For example, Procedure for obtaining NAFCC Funds for state projects.

4. Monitoring of SAPCC- Department can consult the secretariat on matters related to the implementation of SAPCC while secretariat will also carry out periodic monitoring on the implementation of SAPCC and utilize appropriate tools to record, produce and update the SLSC on the implementation of SAPCC. All the data / information and reporting by concerned departments, agencies and concerned stakeholders should be periodically furnished to the secretariat.

The nodal agency shall be allocated budget or financial assistance from the state for carrying out its activities. Each of the concerned departments will appoint a nodal officer on climate change to interact and deal with the climate change secretariat.

The nodal agency will be guided by the State Level Steering Committee headed by the State's Minister for Environment & Climate Change, Chief Secretary & Environment Secretary & other members. The SLSC will not only guide but also provided approvals as necessary. State departments will also form a part of the SLSC.

The State Governing Council, headed by Honourable Chief Minister will be the overall guiding body along with Chief Secretary, Environment Minister for strategic climate change issues in the state. It will constitute of Honourable Chief Minister, Hon. Minister for Environment & Climate Change, Chief Secretary, key experts, and nodal officer of the secretariat and others may be included as necessary.

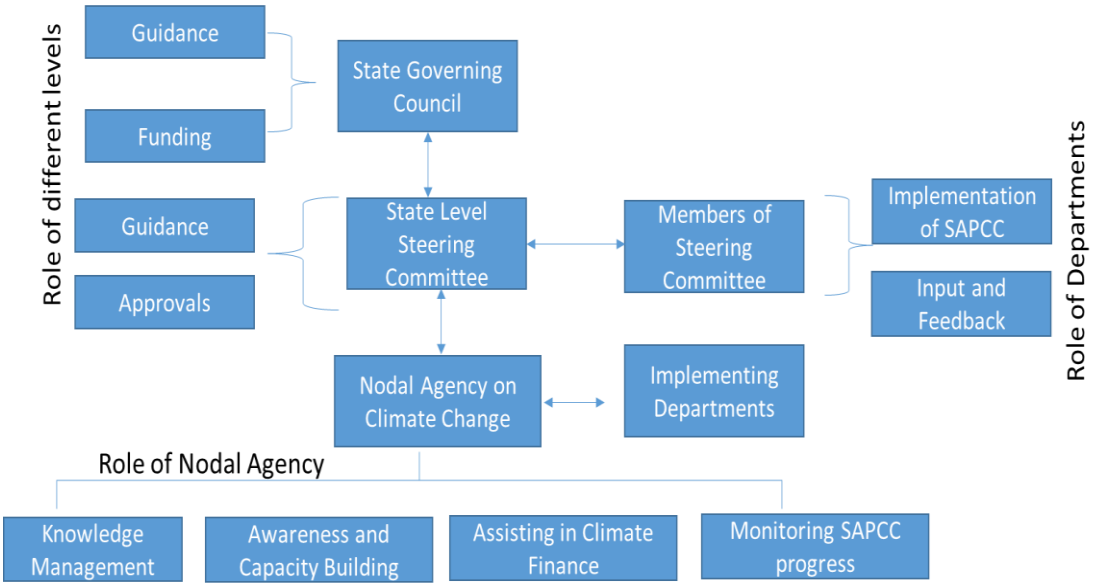


Figure 32: Institutional Mechanism for Implementation of SAPCC

10.2. Knowledge Management

Climate change is a dynamic subject, and the knowledge about climate change and its region-specific topics are currently scattered, limited and unorganized often making it difficult for departments to effectively utilize and integrate climate change in policy development and routine actions. Thus, their a need to systematically organize, synthesize, regularly update and provide information about climate change in the context of Goa to all stakeholders. At the same time, various institutes in the state are involved in climate change-related data gathering and analysis.

In this context, it is proposed that the secretariat on climate change undertakes the responsibility of collaborating with various agencies and institutes, collation of knowledge/data products available with them and to further continues to develop meaningful outcomes for the state.

Thus, under the National Mission for Strategic Knowledge on Climate Change, it is proposed that a climate change hub is created at the Secretariat. Following activities are proposed to be undertaken by the hub in a collaborative:

1. Creation of knowledge management portal
2. Formulation of integrated databases to assist the policymakers take informed decisions while formulating policies.
3. A collaborative project to continuously provide climate change trends and model projects for Goa. For this purpose, the secretariat may collaborate with state and national level institutes like BITs Pilani Goa and NIO, Goa, IITM Pune and any other institutes of organizations found related.
4. Develop Sectoral climate impact assessments
5. Develop and periodically update sectoral climatic vulnerability and hydrometeorological hazard risk for all sectors. In some time, the vulnerability of sectors may change and hence, re-prioritization might be needed. Such a project will help in developing the required knowledge
6. Develop a system to update and record the government's progress on climate change through policies, programs, etc.
7. Develop and provide guidelines to be included in the pre-implementation stage (i.e. feasibility, DPR, etc) for all infrastructure to climate-proof, and minimize climate impact
8. Develop knowledge material and conduct capacity building for all concerned departments and institutes
9. Develop various tools and models for dissemination of climate knowledge among all stakeholders
10. Conduct skill development programs to provide the state with resources trained to handle activities and infrastructure like STP, vermicomposting units, etc.

10.3. Capacity Building, Awareness Raising and People's Participation

Climate change impacts all and it is a must that people understand and appreciate the realistic impacts of climate change that they can expect to experience. It is also important for people to understand their role in minimizing climate change and how to prepare and respond to climate change through adaptation measures. Hence, people's participation is one of the key pillars of the effective implementation of SAPCC.

To enhance understanding of climate change, awareness programs are essential whereas capacity building is relevant for appropriate action at all levels. During stakeholder consultation at Goa, community involvement was emphasized with specific reference to youth and school children.

Based on the above following activities are proposed:

1. **Including climate change as a mandatory part of school education**

Standardized modules will be created for generating awareness among school children on climate change with specific reference to the local context. Selected teachers from all schools would be provided with training on climate change. Schools will be provided with the audio-video course module which the trained teachers can use for further educating children

2. **Involving the youth in climate action**

Middle and higher secondary school children will be provided with opportunities to participate in community action on climate change through the school. Youth from college will be educated on climate change in the local context, future career opportunities related to climate action, skills needed and courses for skill development. A program will be developed and implemented to identify youth mascots for further spreading awareness on climate change in the state through various mediums.

3. **A community-level task force (CLTF)**

The community-level task force will be developed at an appropriate level through a structured program to not only create awareness but to also act as disaster averting and the first line of action during climate disasters. CLTF will also assist in gathering land documenting local/indigenous knowledge related to climate change indicators, and actions available to address climate change. The same will be appropriately vetted and included in the knowledge management system.

4. **Capacity building at the departmental level**

Every government employee needs to understand the local context of climate change, the expectation from them in implementing climate change initiatives and enhancing their ability to contribute to the same. A structured program with appropriate tools and implementation mechanisms will be developed by the Secretariat.

5. **Women leaders in climate flight**

Globally, women and children have been identified to be amongst the most vulnerable to climate change. Hence, it is essential to ensure that women and women-specific issues arising out of climate change are addressed appropriately. It is proposed that women SHG's and other women leaders will be identified to ensure that women are well informed on the local context of climate change, their issues are addressed or solution is identified. It is suggested that an appropriate program is developed for women.

11. Monitoring and Evaluation of SAPCC

Implementation of SAPCC would require the state government to channelize a significant amount of investment. Hence, it is essential to measure the effectiveness, efficacy, and efficiency of SAPCC during the implementation phase. A robust monitoring and evaluation system will ensure that the progress of implementation is appropriately measured and captured, provide accountability for implementation and also to draw lessons for the future from the measures being implemented. As measures to contain and adapt to climate change are multi-dimensional and may have constantly changing climatic parameters, a robust M &E system will provide a way forward to strengthen the SAPCC periodically.

Developing monitoring and evaluation indicators for climate change adaptation activities is challenging as it is often independent of other factors like human development, other changes in the environment.[26]

In view of the above the M&E framework consists of:

1. Qualitative and quantitative indicators of adaptation
2. Indicators are attempted to be as ambiguous as possible
3. Monitoring, reporting and communication process for departments and the policymakers

11.1.1. **M&E framework**

SAPCC implementation is proposed to be reviewed and review and progress report to

be submitted by the state nodal agency to the SLSC, annually before state budget

preparation each year, to

a. Ascertain the financial resources spent on CC under projects/interventions, by various departments and concerned organizations
b. Provide progress on ground level implementation based on indicators
c. Provide a plan for next year, with any changes or deviations from the SAPCC
d. Provide a plan for expenditure on CC and additional financial resources needed from the state budget

As SAPCC implementation involves multiple stakeholders from different sectors and administrative groups, requiring interdepartmental coordination, in some cases, it is proposed that **a working group** is formed to facilitate transparency, coordination, communication, and learning. The working group must focus strongly on the MRE process.

[26] UNFCCC synthesis report on monitoring and evaluating adaptation: http://unfccc.int/resource/docs/2010/sbsta/eng/05.pdf

Climate change secretariat and nodal climate change representatives from each department can be part of the working group. The working group will be chaired by the climate change secretariat. The working group will meet at least every quarter to discuss the progress on the interventions presented in the SAPCC, challenges being faced during implementation and way forward. Working groups quarterly report will be presented to the SLSC members. Apart from a working group, other modes of wider stakeholder engagement will also be explored to enhance the M&E process. Data on certain M&E parameters will be provided by the concerned departments to the secretariat periodically which maybe once a quarter.

Systematic reporting by nodal agency and meeting of State Steering Committee on Climate Change to review the progress shall be undertaken at least twice a year.

As a next step, it is proposed that a state-level climate change performance index is developed for the inter-departmental progress and performance mapping on climate change.

11.1.2. Review and Updating of SAPCC

The SAPCC has been developed for a time frame of 10 years starting from 2021. However, climate change being a dynamic subject, with shifting baselines, the results generated by reports of M&E may suggest to the decision-makers a necessity to revise significant aspects of the SAPCC mid-way. To facilitate the assessment of such need, it is proposed that the SAPCC is reviewed in a period of 3 years from the start date of approval. For this to happen, findings need to be documented and analyzed systematically and communicated to a range of decision-makers, at the right time and in an appropriate way.

If the annual M&E reports do not suggest any need for revision in the first 3 years, it must be assessed once again midway during implementation. However if there is availability of critical data or information (eg. High resolution data from satellites etc.) which could lead to significant change on the SAPCC at policy level then SLSC for NAFCC may take appropriate decision to update SAPCC.

11.1.3. M&E indicators

Indicators play a critical role in M&E systems. To develop effective indicators, it is essential to have a pragmatic approach. It is also essential that they are an effective representation of progress on climate change mitigation and adaptation. The indicators proposed in this SAPCC for M&E have been consulted with the departments and agreed upon by them. Quantitative indicators are more favourable towards policy and decision making, hence, the indicators in this SAPCC are skewed towards the same.

Table 30: Indicative Sectoral Indicators for M&E

Transportation Sector	**Monitoring Frequency**
Percent reduction in road closures due to landslides or flooding	
Percent reduction in flooding where drainage capacity has been increased	
Improved decision making and sector planning based on climate change considerations	
Transport sector planning documents include adaptation strategies	
Length of road constructed to withstand climate change impacts	
Area of mangrove planted to protect coastal roads	
Percentage increase in population carried through public transport	
Percentage increase in number of bus stops	
Percentage increase in length of path provided for non-motorized transport	
Percentage increase in the distance traversed in km by the public transportation system	
Agriculture Sector	
Agriculture sector planning documents include adaptation strategies	
Number of hectares where climate-resilient cropping practices are introduced	
Number of hectares/communities where rainfall capture and adaptive irrigation management are introduced	
Area of mangrove planted to protect coastal agricultural land	
Number of agricultural officers, extension workers, and farmer cooperatives in target districts trained in climate change impacts on agricultural production and potential community-based adaptation options	
Agricultural land use planning in flood- and drought-prone areas analysed and alternative land use plans developed based on climate risk scenarios	
Improved decision making and sector planning based on climate change considerations	
Percentage of khazan lands protected	
Percentage of population depending on khazan lands provided with alternate livelihood options	

Percentage of non-efficient agricultural pumps replaced with energy efficient and solar pumps	
Energy Sector	
Percentage reduction in transmission and distribution loss	
MWh of solar power plants installed	
MWh of power through other alternate sources of power	
Percentage reduction in increase in power consumption	

Indicative Budget Estimations for Implementation of Climate Change Related Programs in The State of Goa		
Sr. No.	**Sector**	**Budgetary Plan for Next Ten Years (In Crores ₹)**
1	Transport	75.00
2	Power (Energy) (50 Cr) & Renewable energy (GEDA - 25 Cr)	75.00
3	Water - WRD	50.00
4	Agriculture and Allied (AVHS) sector	50.00
5	Environment & Coastal Management - Bund restoration , erosion control and other initiatives for climate resiliency	50.00
6	Forest Sector	25.00
7	Fisheries sector	25.00
8	Biodiversity & Wetlands	25.00
9	Solid Waste Management	25.00
10	Sewage Management	15.00
11	Human Health	10.00
12	Disaster management, Climate migrants & refugees	10.00
13	Habitat	10.00
14	Tourism	5.00
15	Mining	5.00

16	Land use land cover	5.00
17	Infrastructure	5.00
	Rupees ₹ Four Hundred Sixty Five Crores Only for Ten Years	**465.00**
	Total SAPCC financial projections of ₹ Rs465/- Crores for ten years works out to be ₹ 46.5 Crores Per Annum and amounts to approx 0.22% of Annual Budget and 0.050 % of Gross State Domestic Production (GSDP) of Goa State.	

Annexure I:

Acknowledgement to Individuals for SAPCC

Names of individuals who have contributed vide their inputs/response to questionnaires by prepared by GSBB.

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Shri. Arturo De Souza
Shri. Manguesh Goankar
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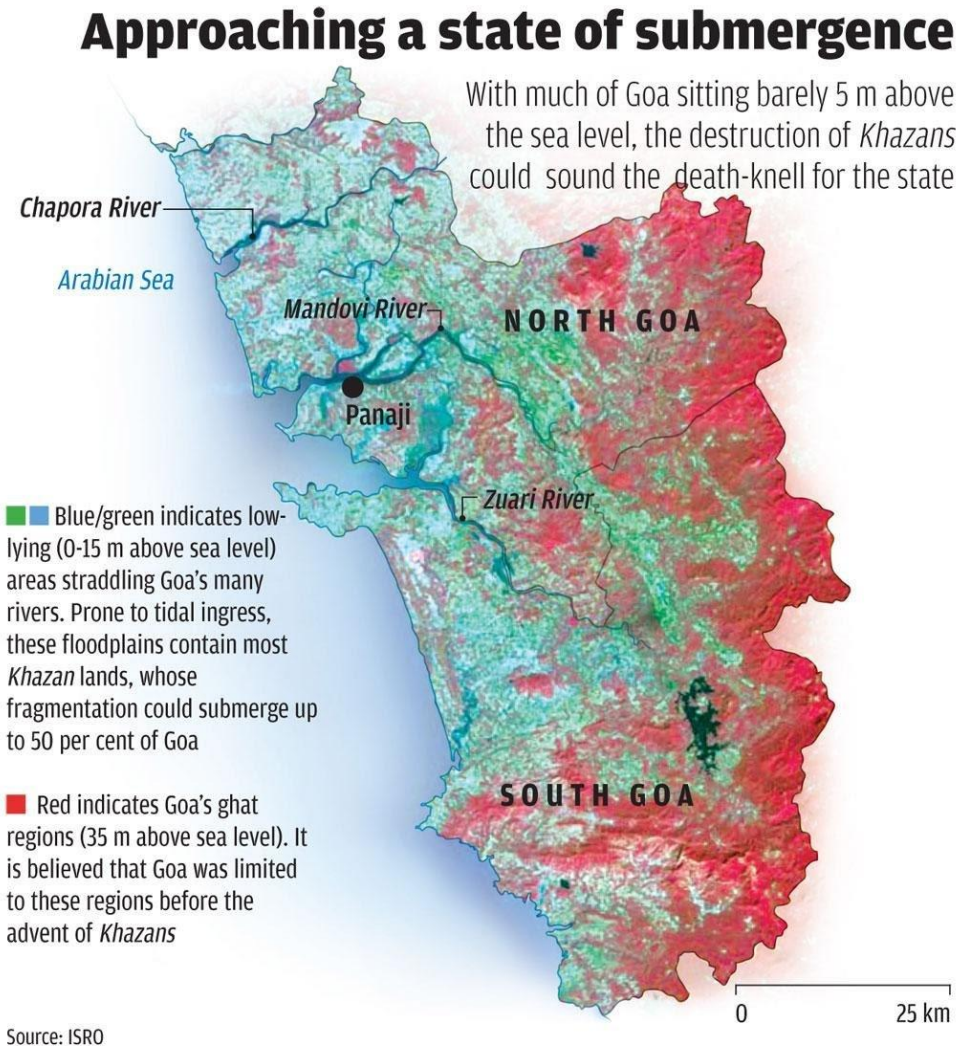
Appendix I: Submergence of Goa



Abbreviations:

SAPCC – State Action Plan for Climate Change

GSBB – Goa State Biodiversity Board, GSWA – Goa State Wetland Authority

BMC – Biodiversity Management Committee