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MINISTRY OF EARTH SCIENCES
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

गोवा राज्य की जलवायु

CLIMATE OF GOA STATE

CLIMATOLOGICAL SUMMARIES OF STATES SERIES - No. 25

ISSUED BY

OFFICE OF THE HEAD, CLIMATE RESEARCH & SERVICES
INDIA METEOROLOGICAL DEPARTMENT
PUNE - 411 005

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P R E F A C E

The importance of meteorology and its economic and social benefits are being increasingly realised all over the world. In our country also, various sectors like agriculture, aviation, power and energy, tourism, shipping, transport industry *etc*. require climatological information pertaining to different regions of the country for planning and execution of different projects. Keeping these requirements in view, it was decided by India Meteorological Department to publish a series of "Climatological Summaries" for each state in the country, incorporating the district climatological summaries. "Climate of Goa" is the twenty-fifth issue in the series of 'State Climatological Summaries'. The climate of this state is prepared for the first time.

The present publication contains district wise climate information on rainfall, temperatures, wind, humidity, clouds and other meteorological parameters for "Goa" state. Information on climatic classification, coefficient of rainfall variation, excessive rainfall, cyclonic storms and depressions, are also included in the publication. Climatic classification over the state is determined by Koppen's technique.

All the data scrutiny, processing, preparation of normals and analysis have been done by group of officers and members of staff under the proficient guidance of Dr. Shirish Khedikar, Scientist B and under overall supervision of Dr. Pulak Guhathakurta, Scientist F, CA&UI Group, CR&S, India Meteorological Department, Pune. All the maps are prepared in house in the CA&UI Group using the software *viz.* Surfer and CorelDraw. The group comprises Smt/Shri G.S.Dhekane, R.S.Wayal, S.M.Deshpande, U.S.Satpute and P.P. Bhagwat. The printing of this volume has been done by the DTP Unit of the office of the Head, CR&S Pune. Dr. D.S. Pai, Head CR&S, Pune provided the necessary guidance.

I am hopeful that this publication will be a useful source of climatic information for societal development.

NEW DELHI
FEBRUARY, 2019

DR. K.J. RAMESH
DIRECTOR GENERAL OF METEOROLOGY

INDIA METEOROLOGICAL DEPARTMENT
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17.	Abstract	The publication contains extensive information on the climate of Goa state and its districts based on rainfall, temperature, winds, clouds and other weather parameters. The information on excessive rainfall, depressions and cyclonic storms is also included in the publication.
18.	Key Words	State Summary, District Summary, Physical Features, Climatic Classification, Heaviest Rainfall, Mean Maximum Temperature, Mean Minimum Temperature, Highest Maximum Temperature, Lowest Minimum Temperature, Rainfall Variability, Seasonal Rainfall, Annual Rainfall.

I N T R O D U C T I O N

The climatology of Goa state of India in terms of various meteorological parameters such as temperature, rainfall, rainfall variability, pressure and winds, relative humidity, clouds, weather hazards, *etc*. is described in state summary, followed by a detailed description of the climate of each district in the succeeding chapters. In this publication, the districts of Goa state which were in existence as on 1st January 2019 have been considered and the climatology of these districts, arranged in alphabetical order is presented.

The normal for each month and annual rainfall are generally based on the data for the period 1961 to 2010. The monthly and annual normal of other meteorological parameters used for describing the climate are generally based on data for the period 1981 to 2010. The extreme values of temperature and rainfall presented in the publication are based on the updated data up to the year 2015. These data have been obtained from National Data Centre, Pune.

The information on cyclones and depressions affected the state during the period 1891-2015 is included in the state summary.

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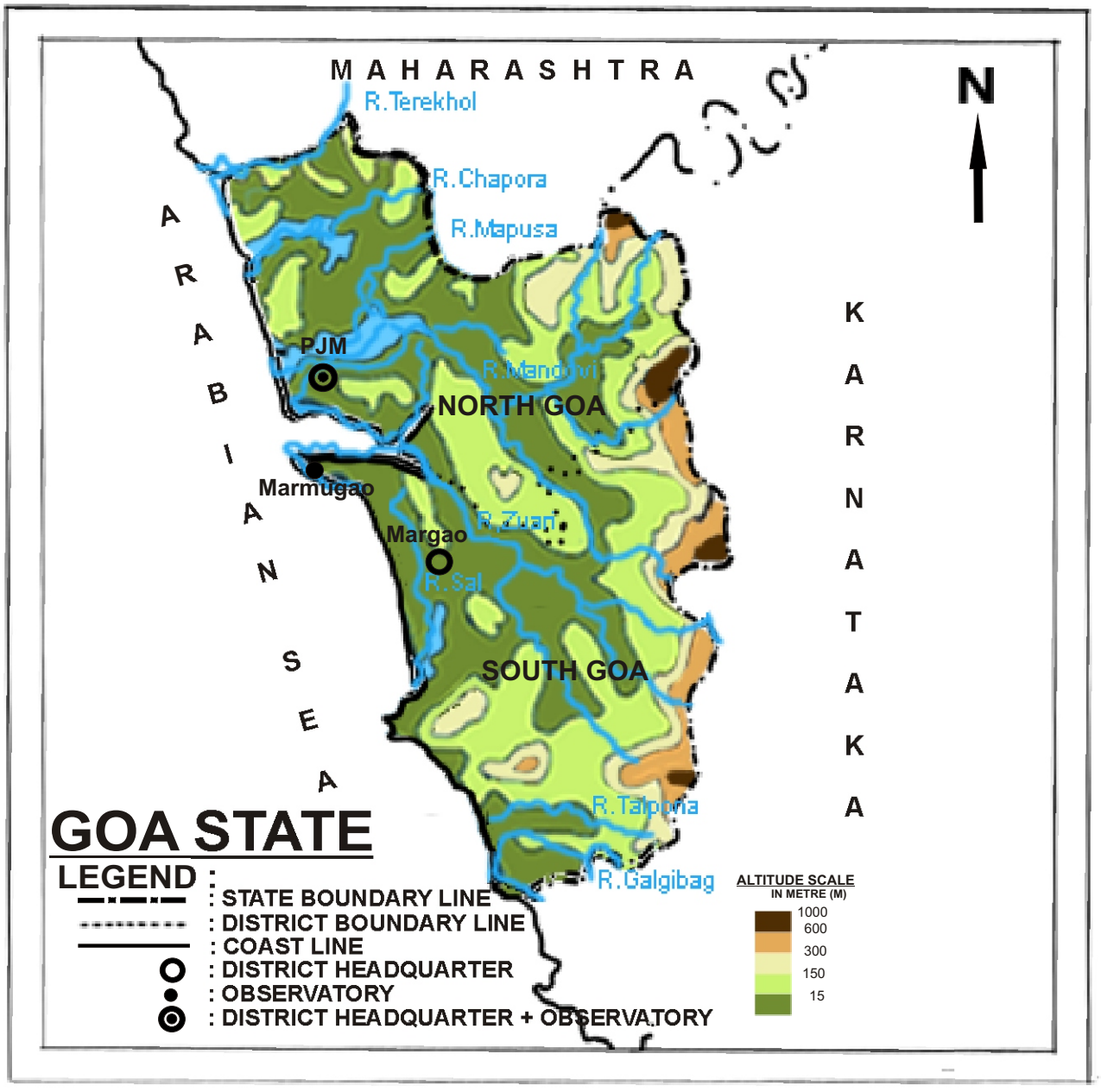

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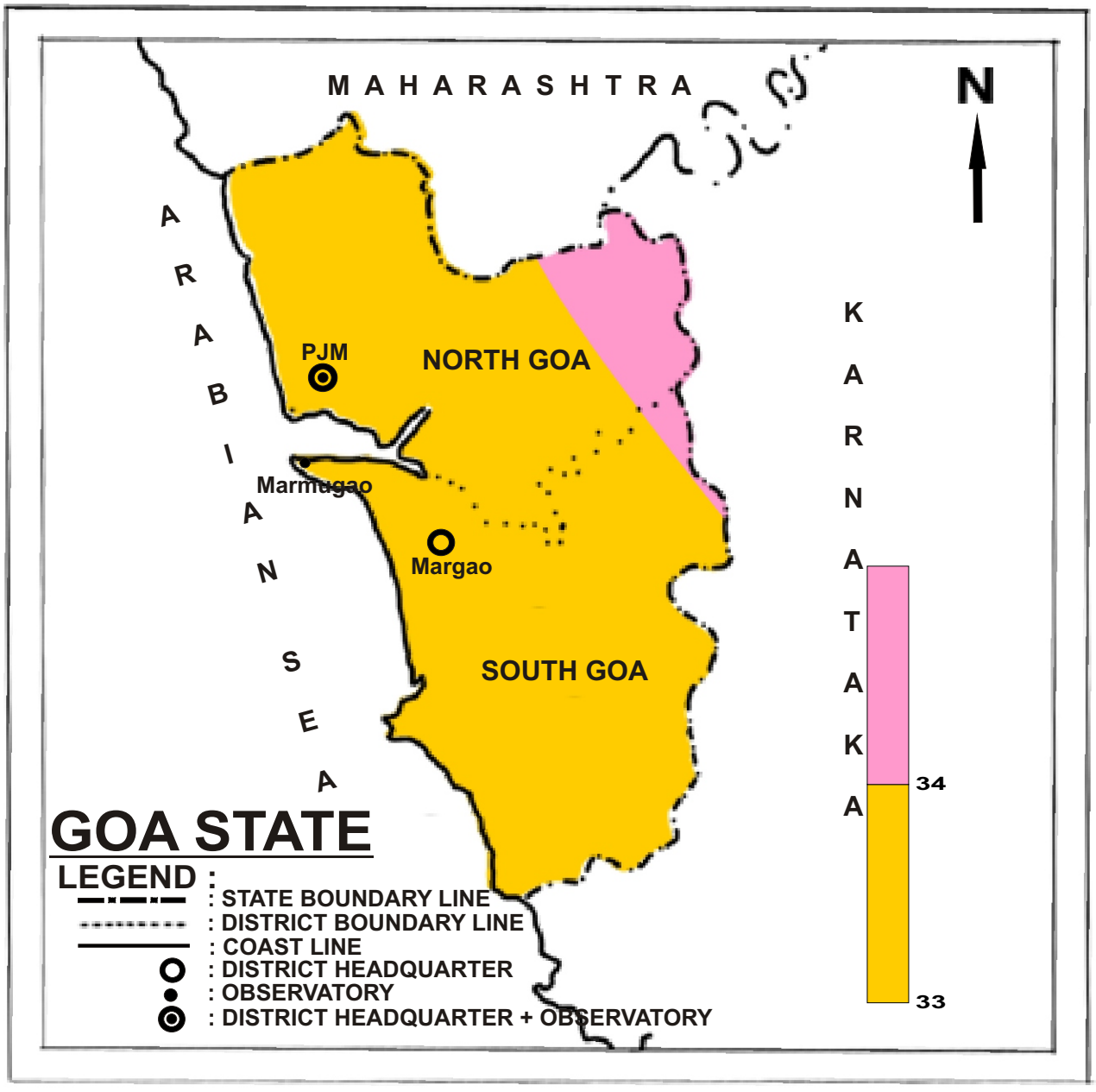

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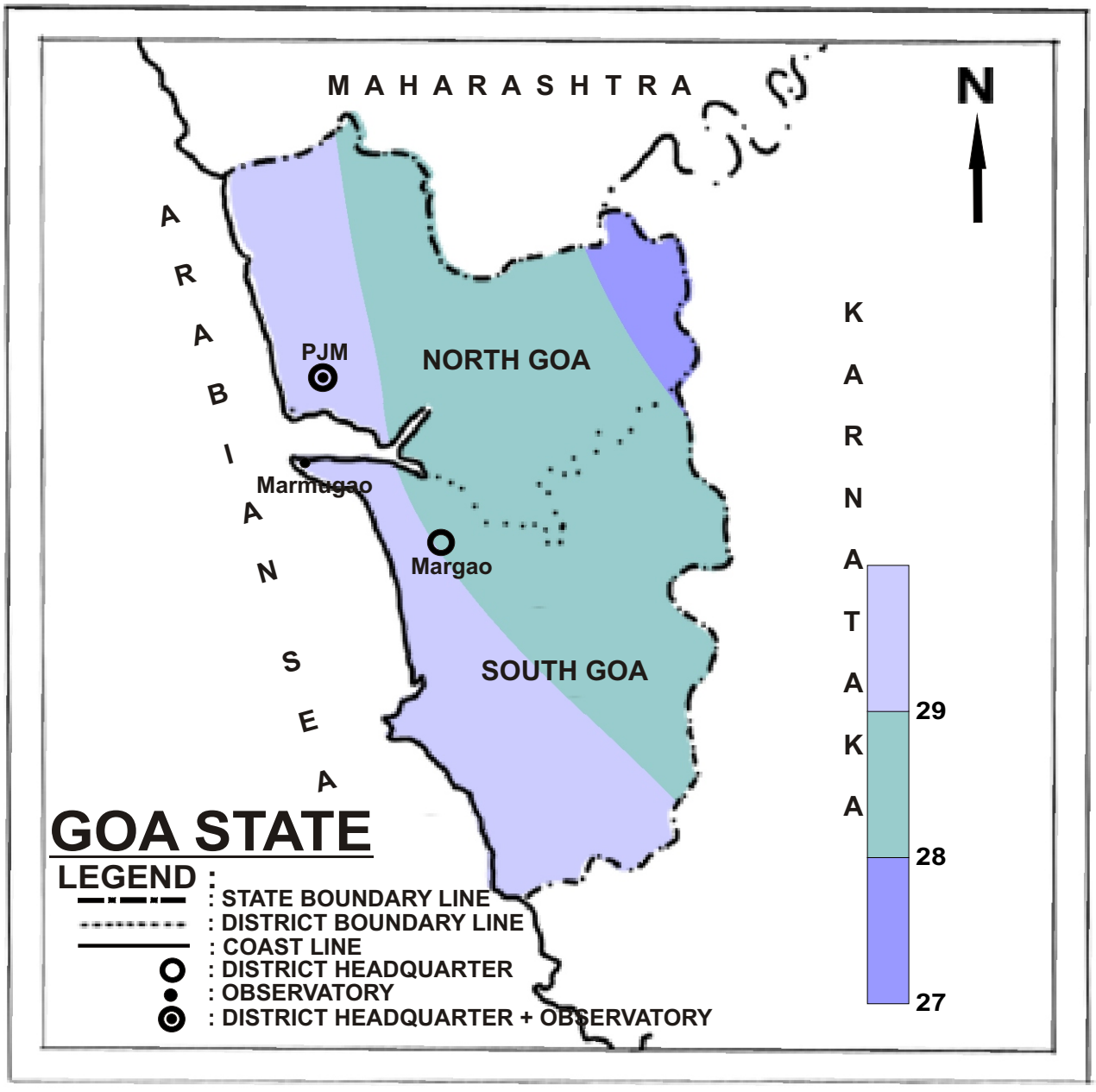

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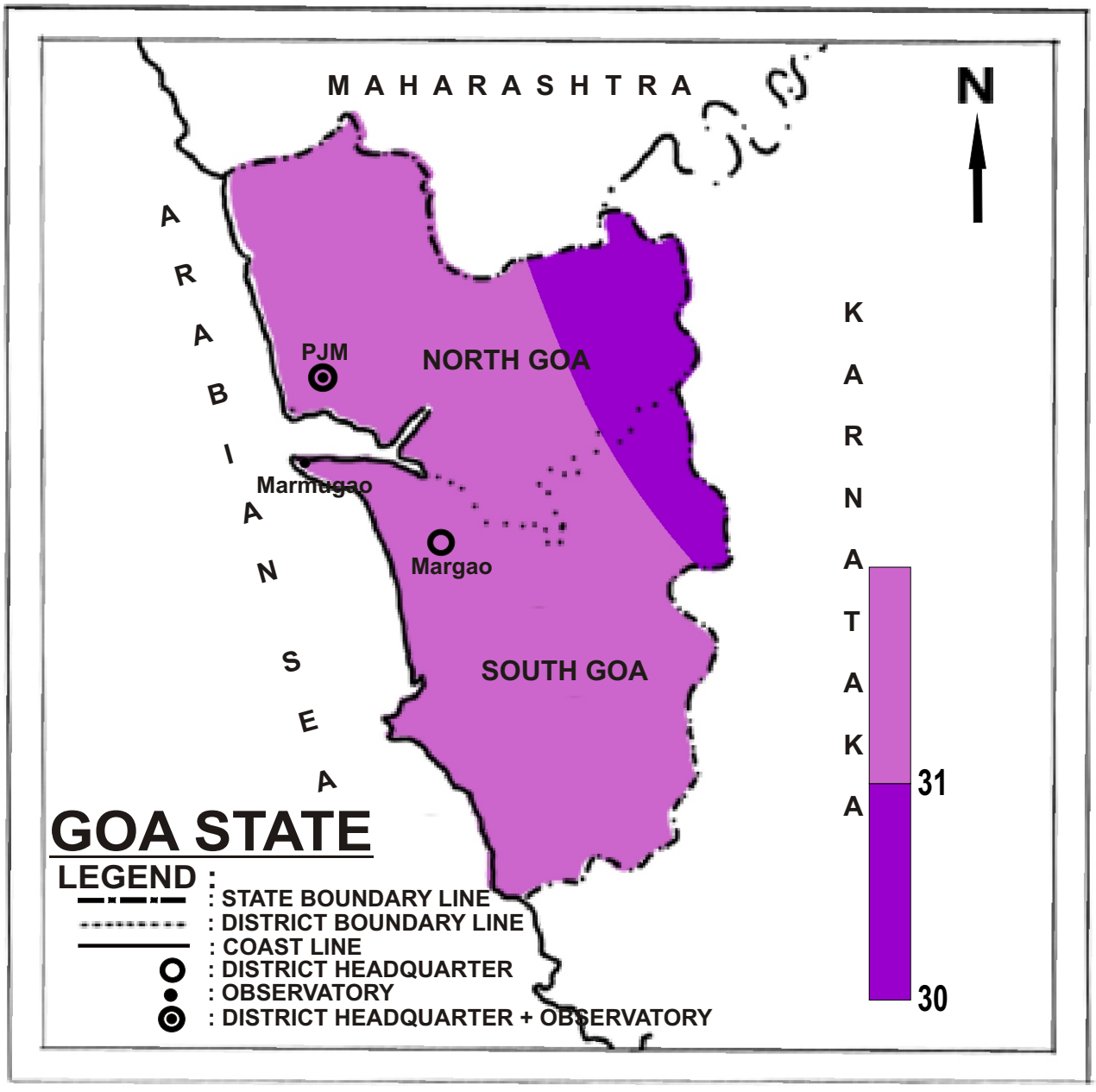

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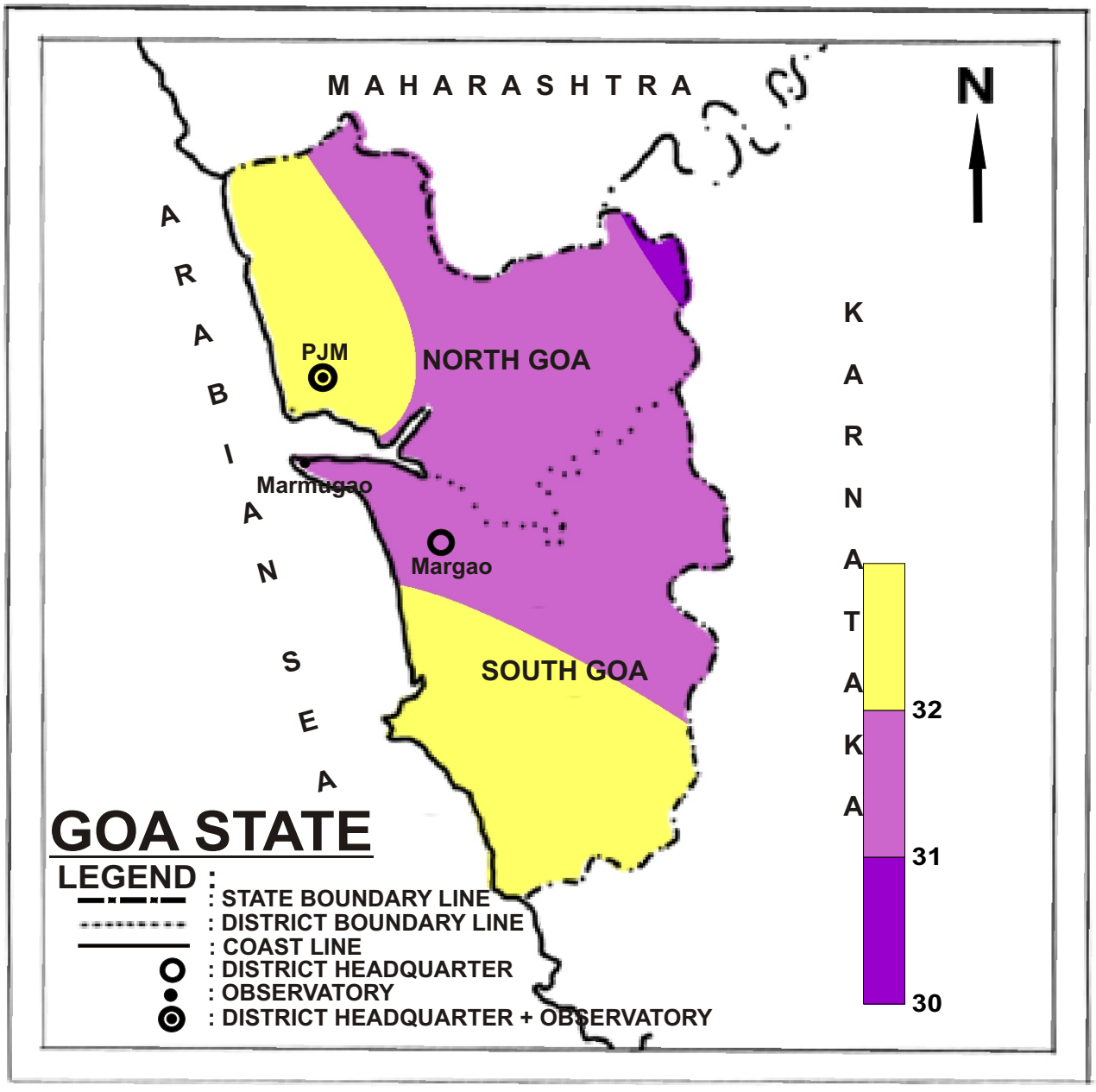

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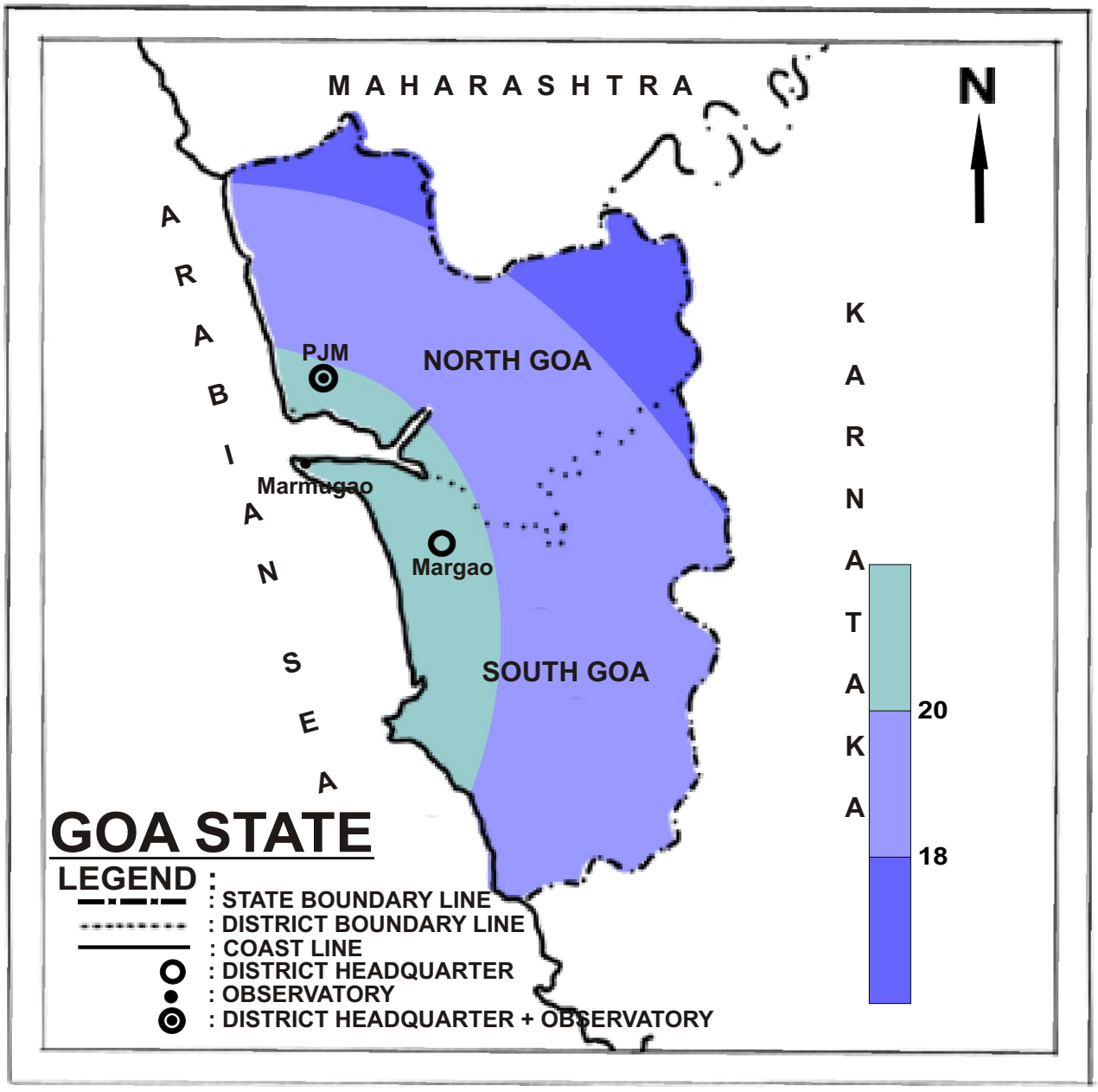

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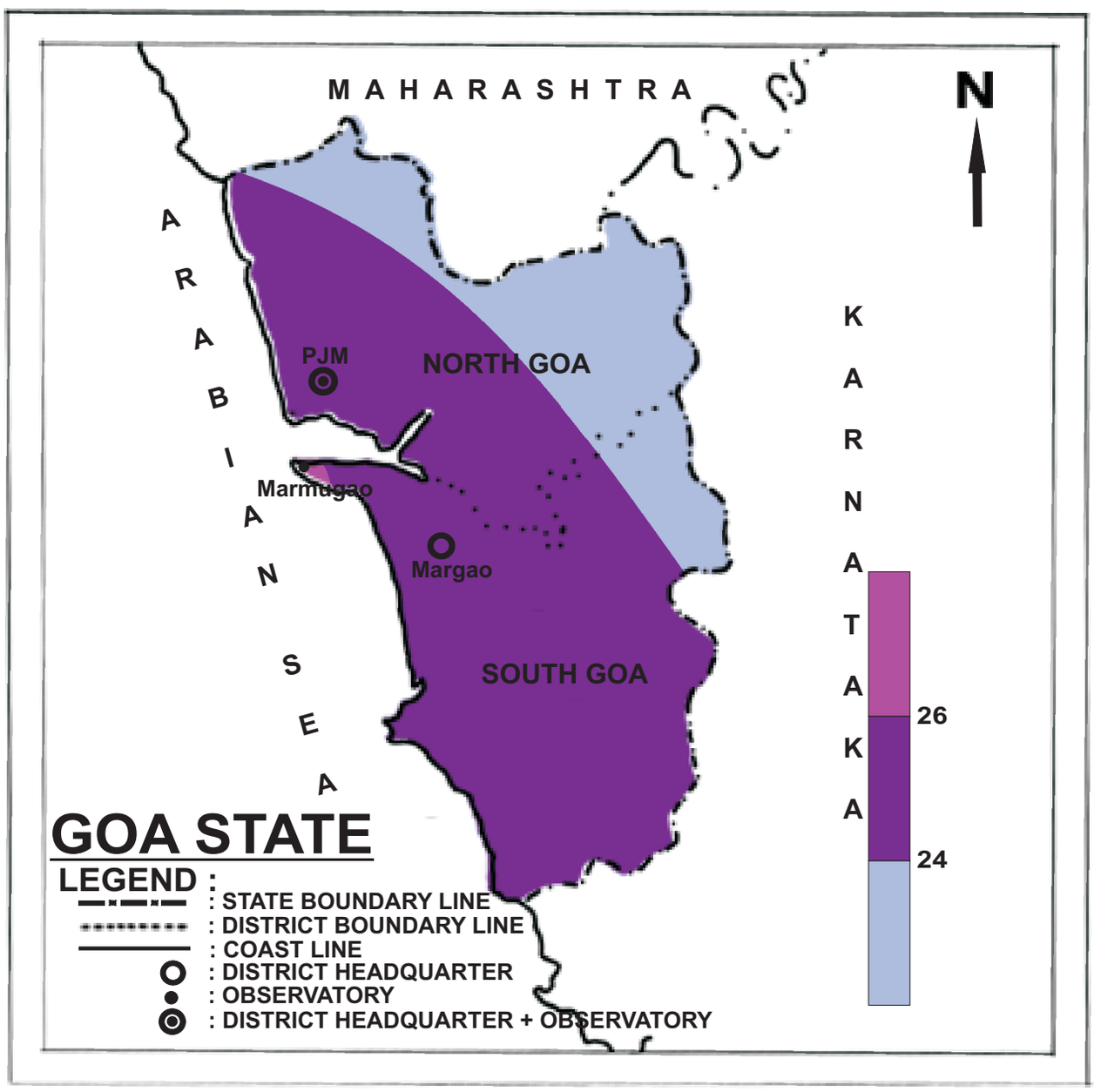

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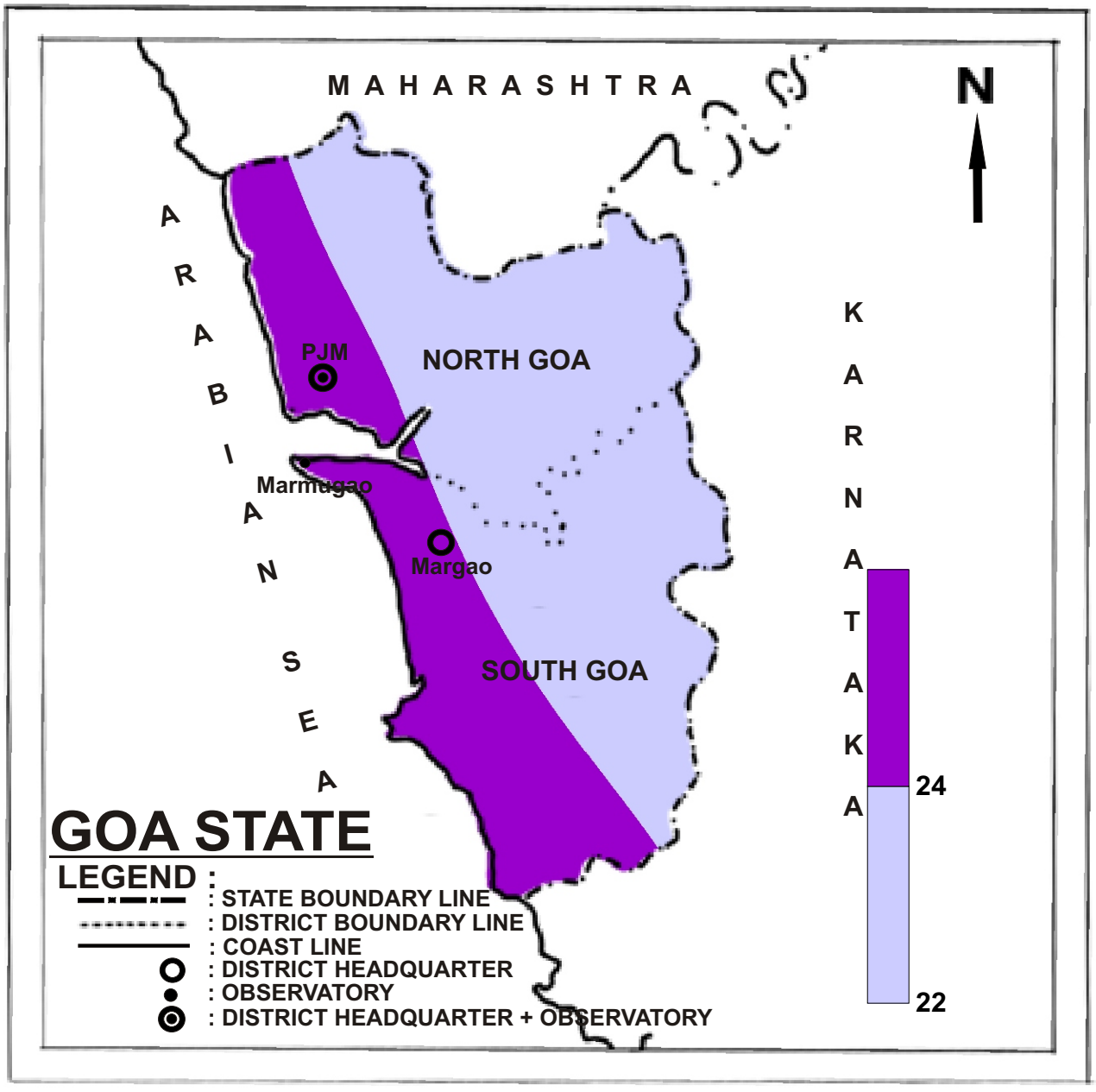

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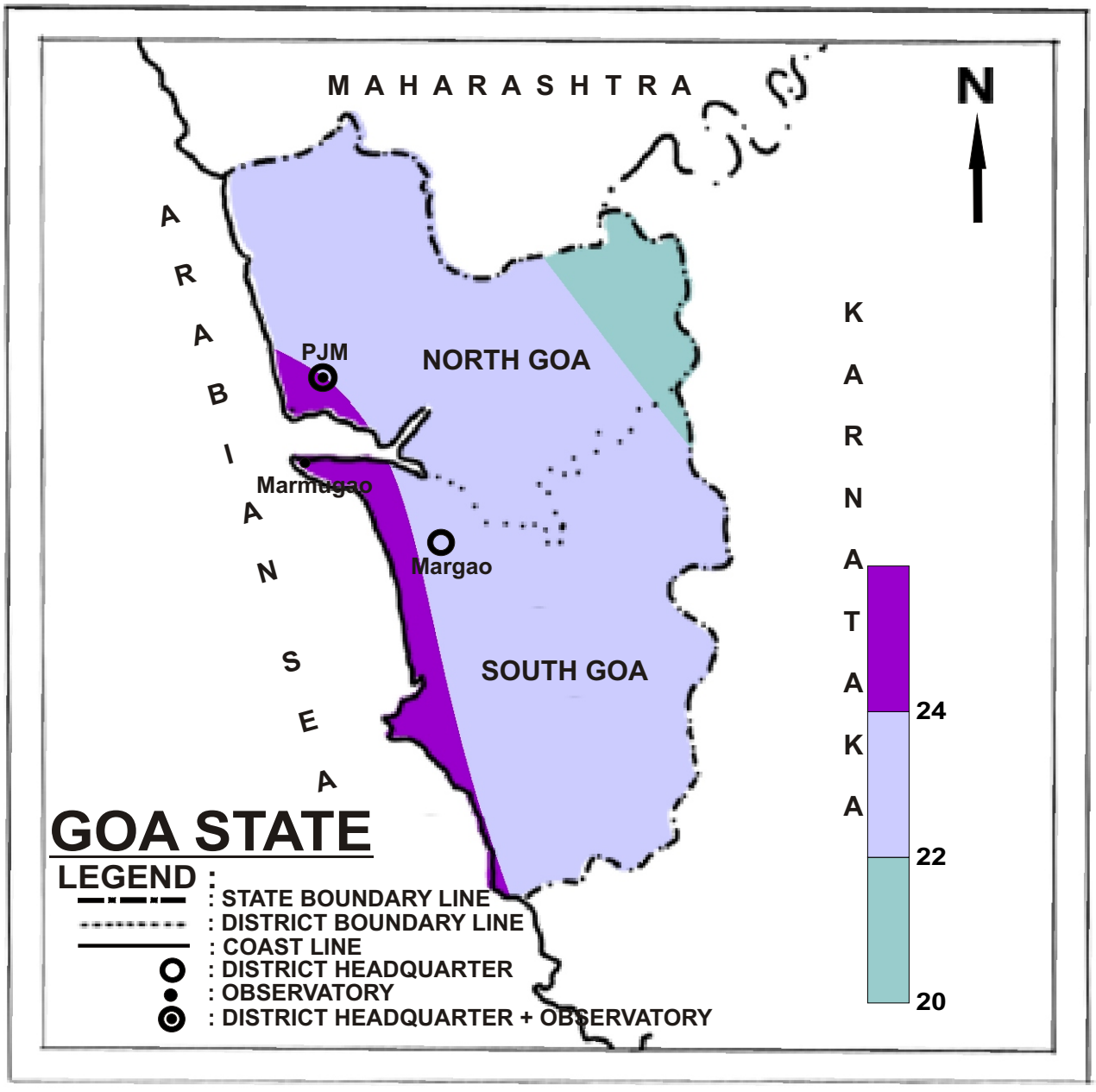

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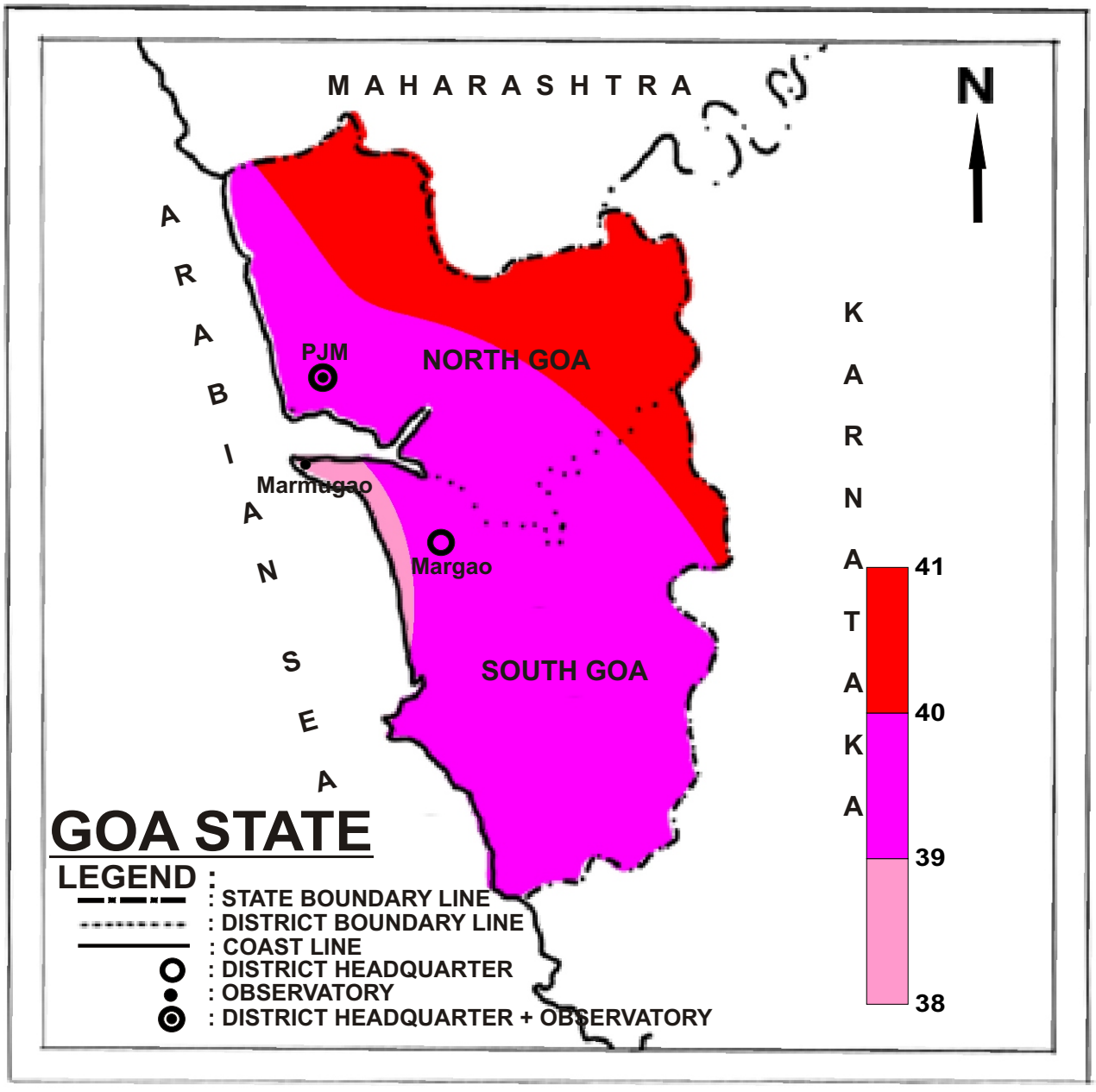

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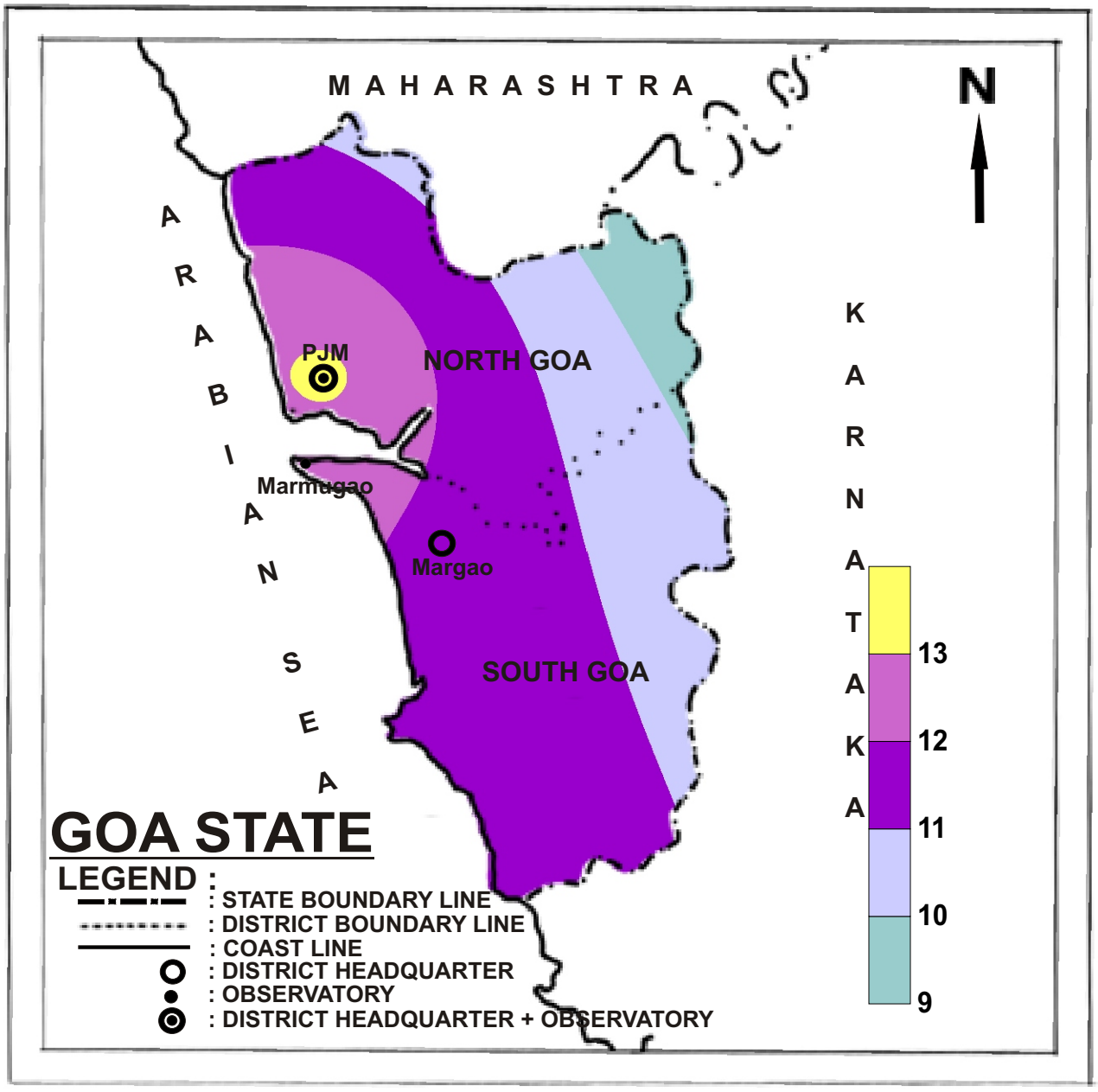

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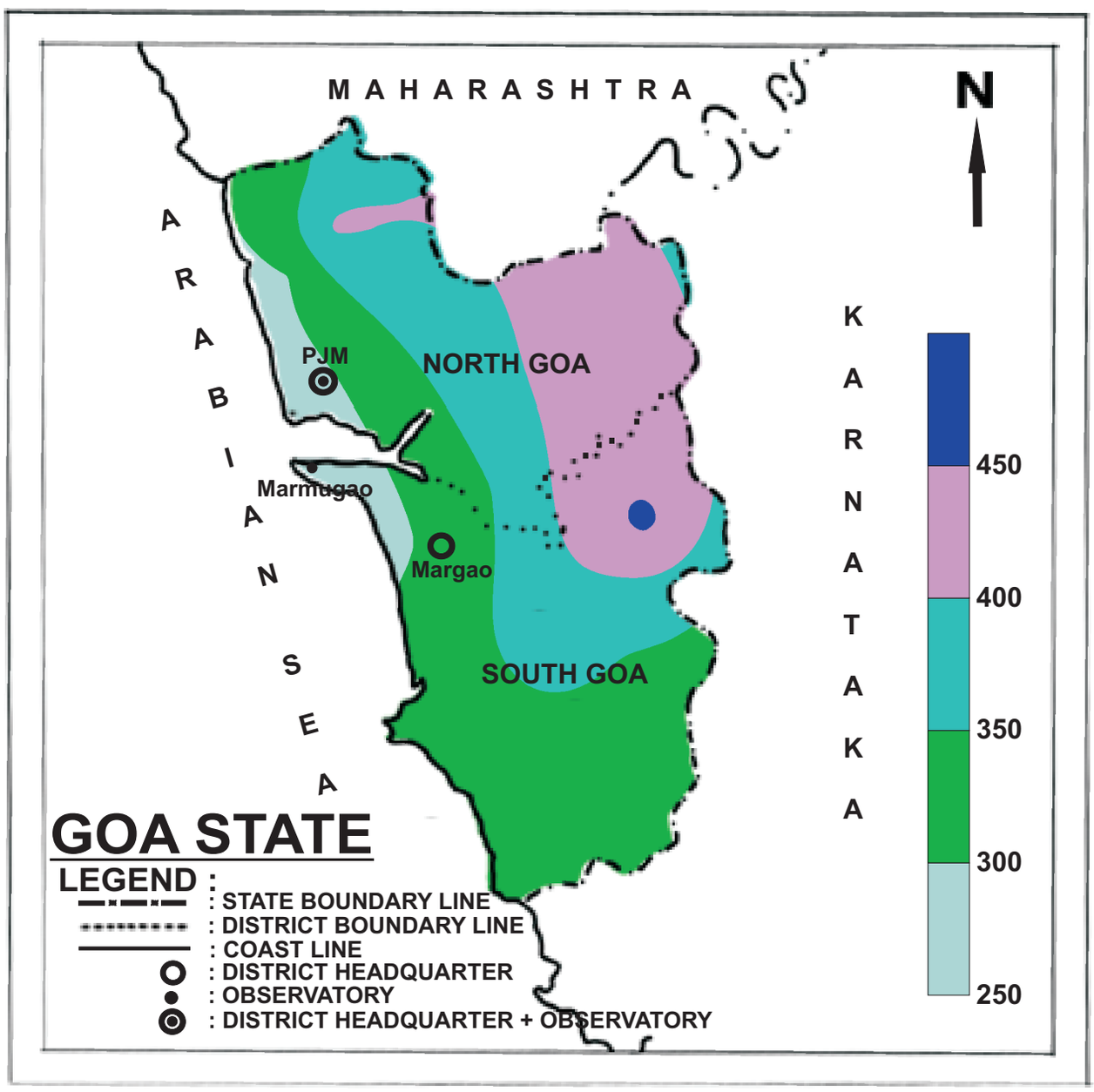

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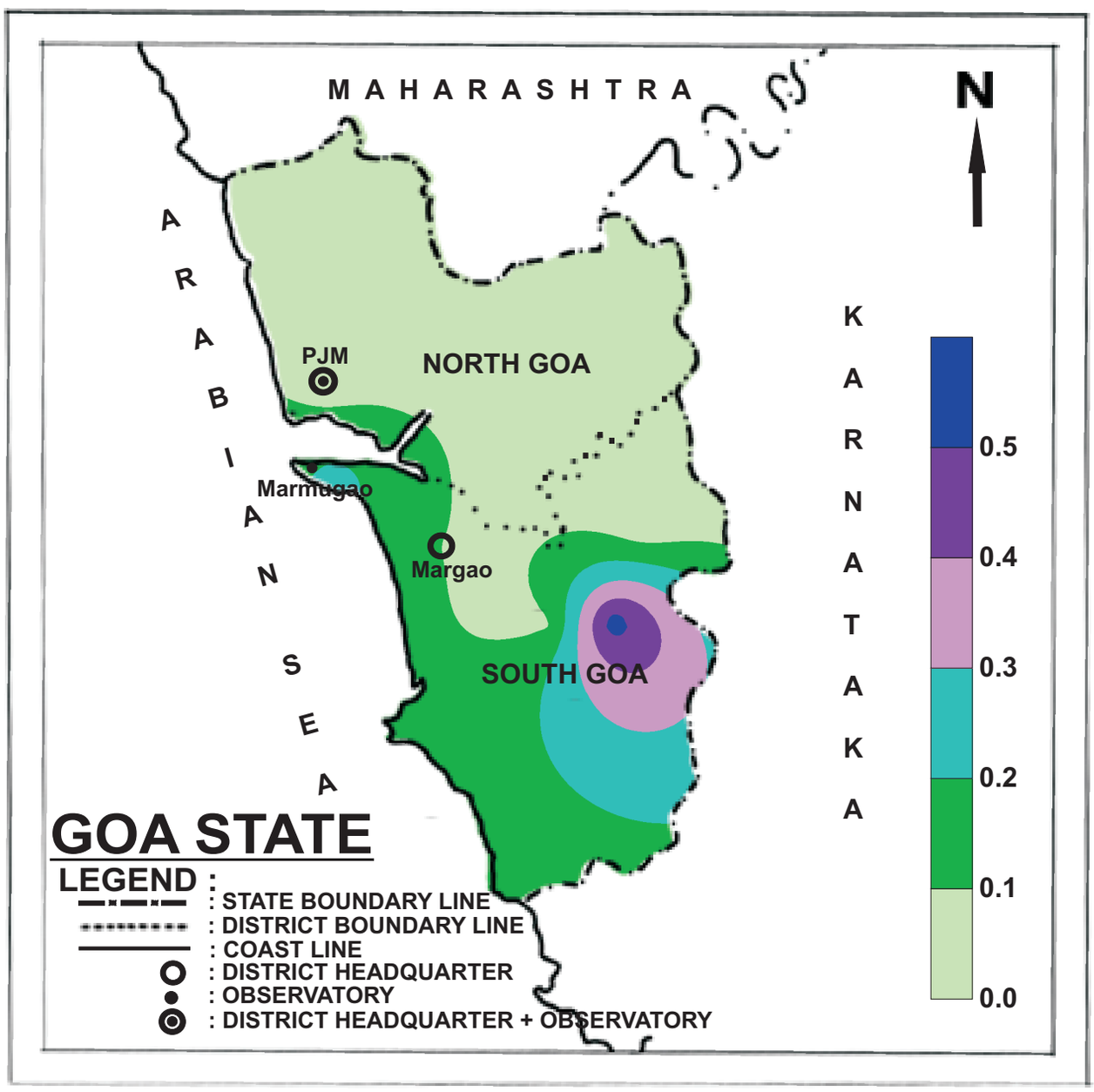

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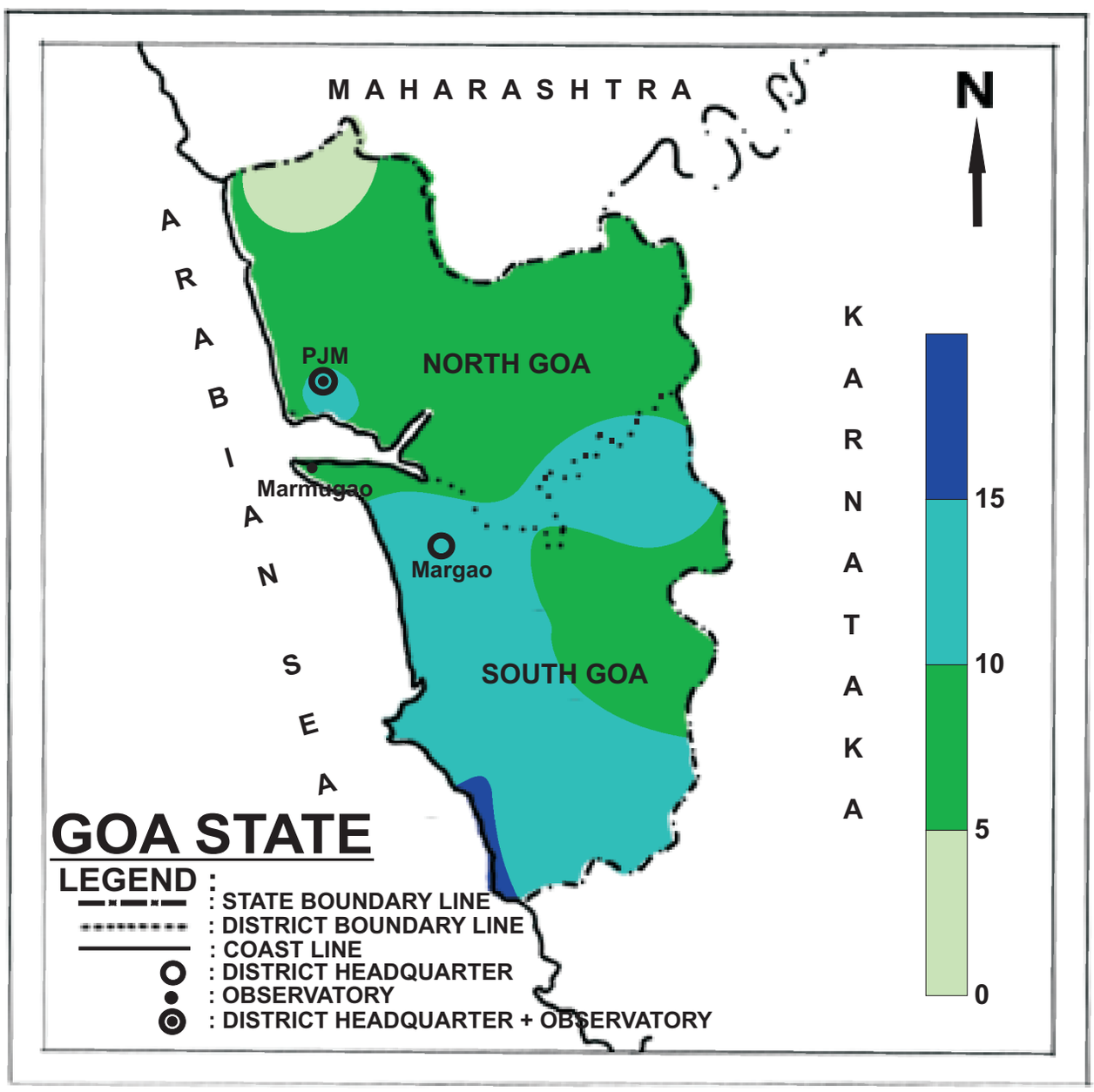

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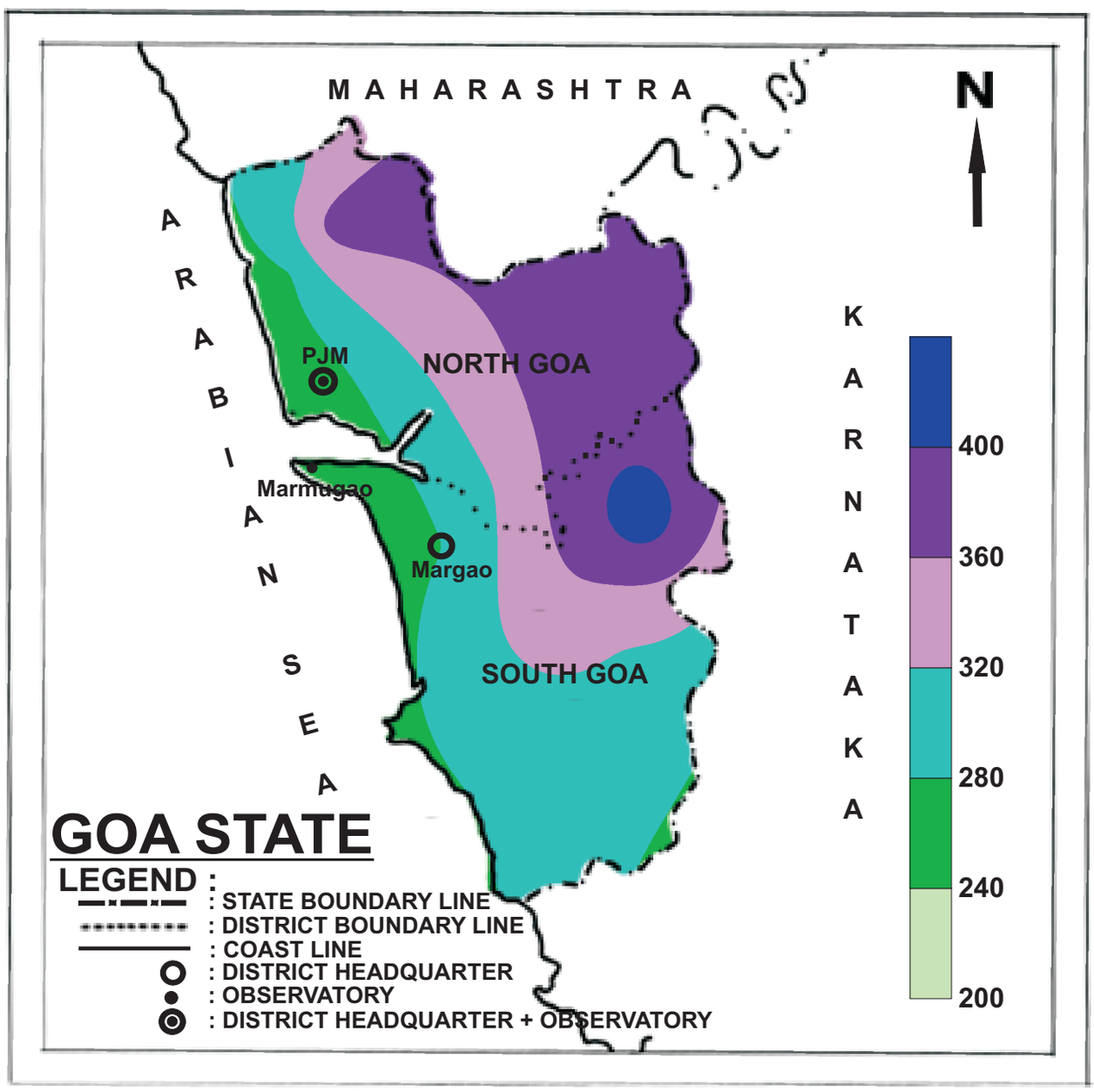

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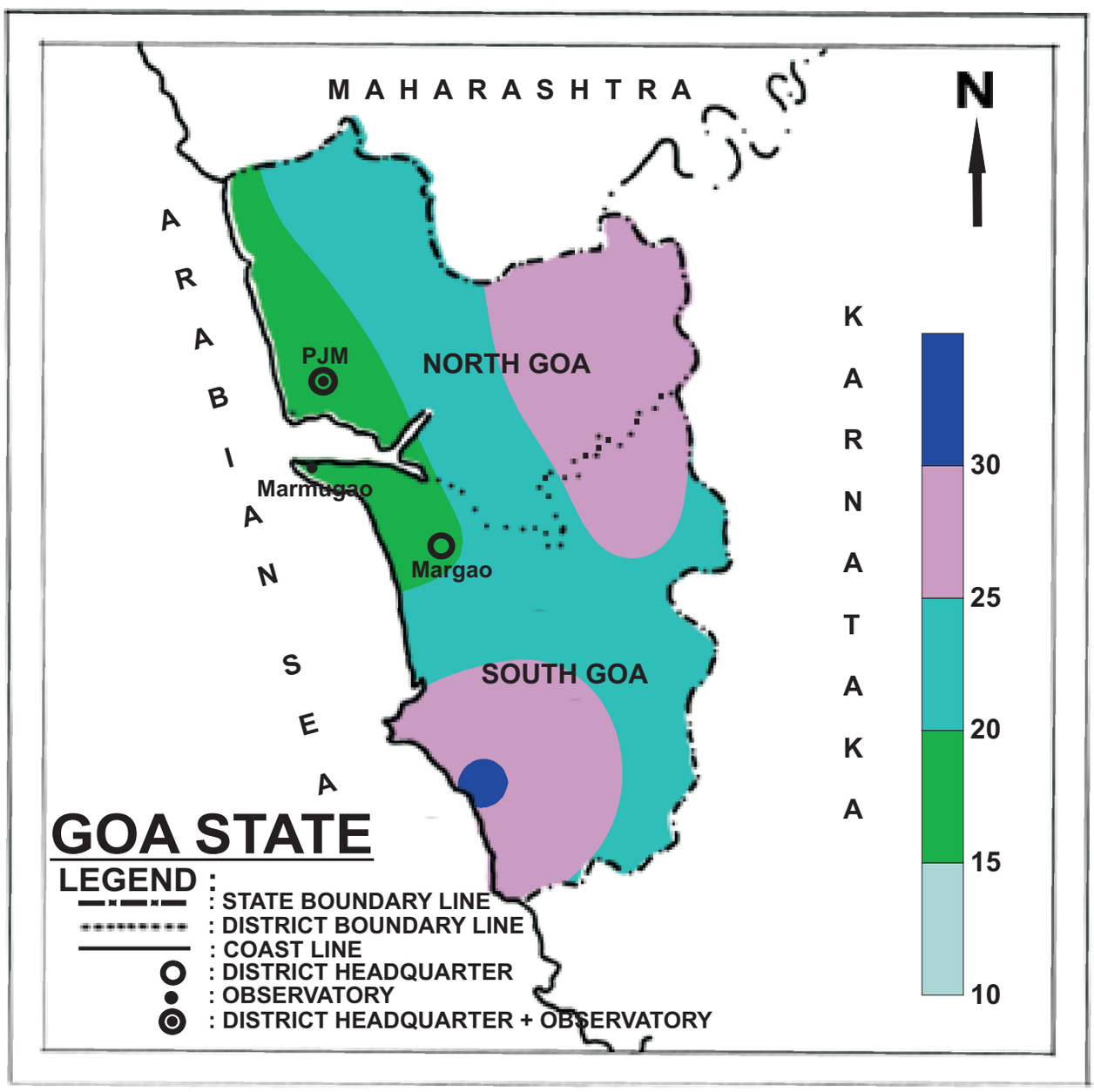

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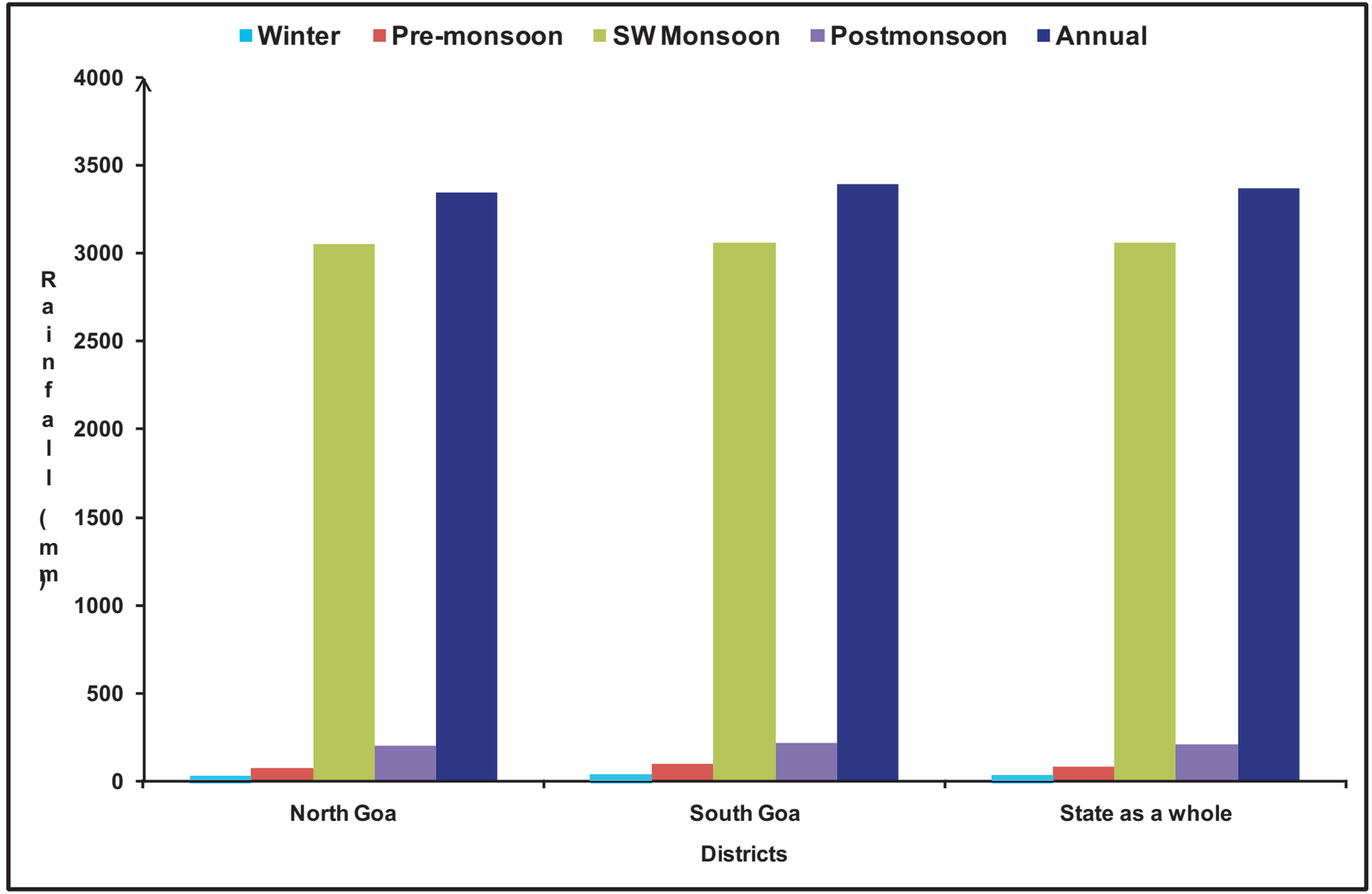

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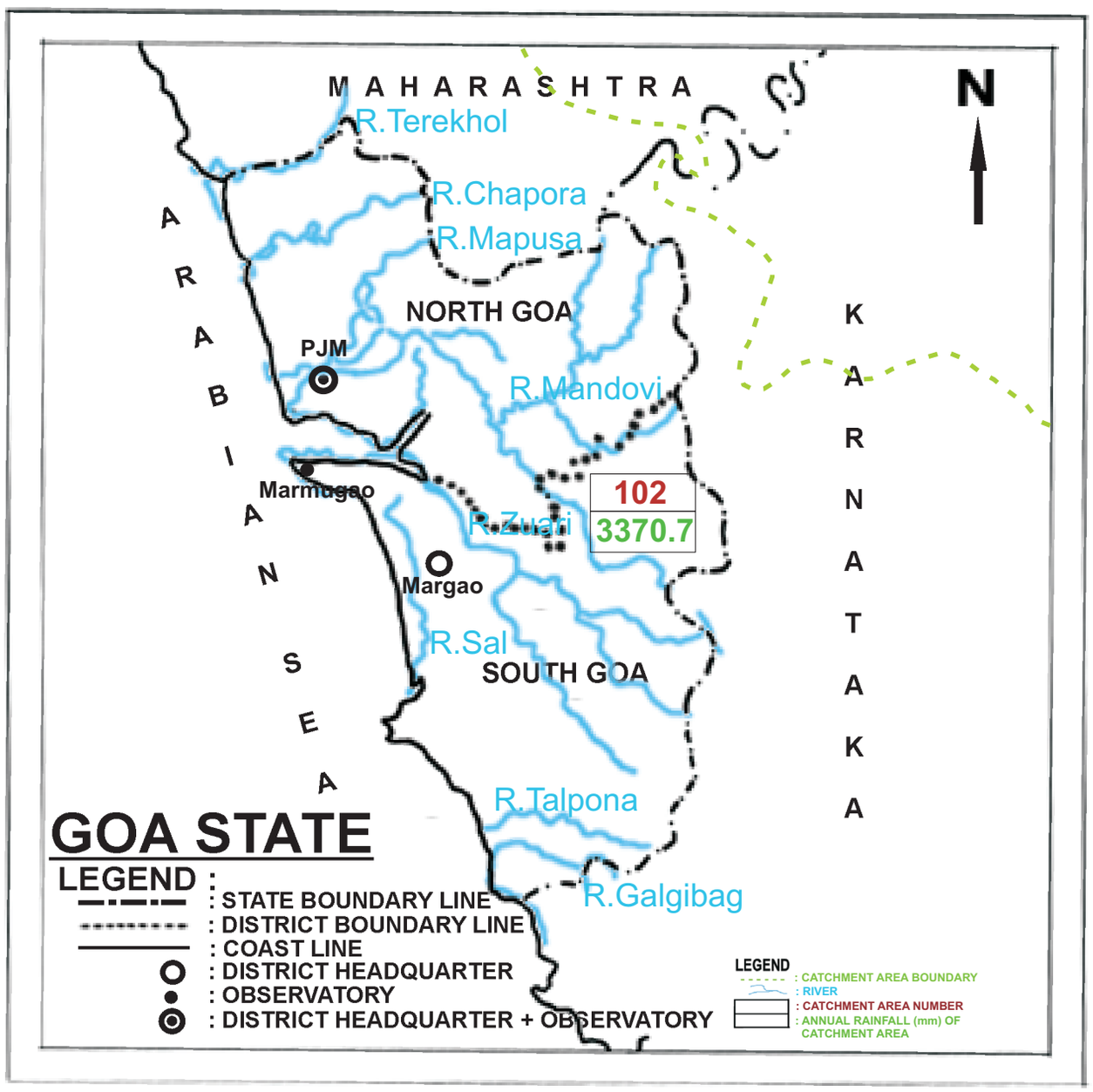

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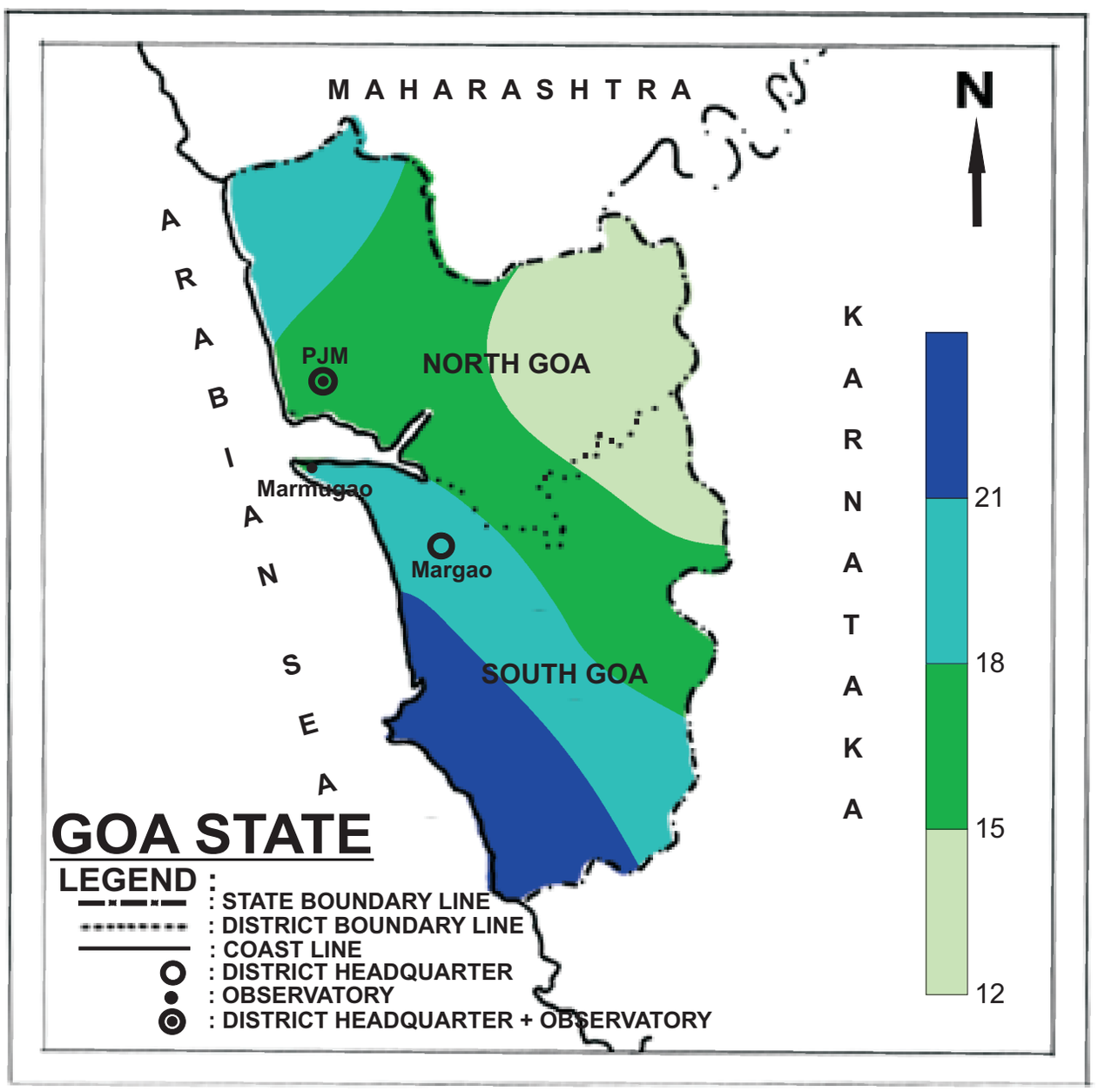

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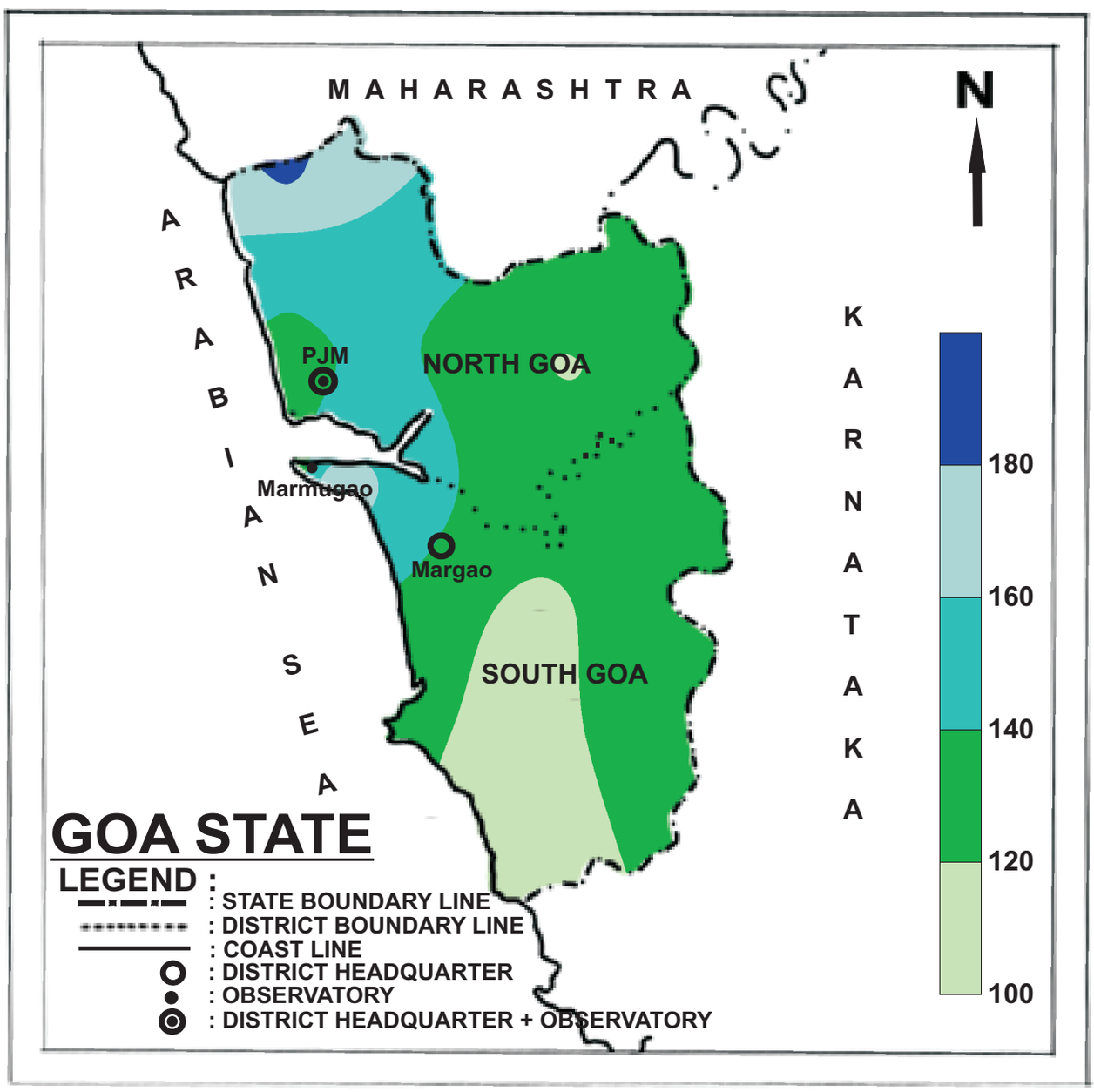

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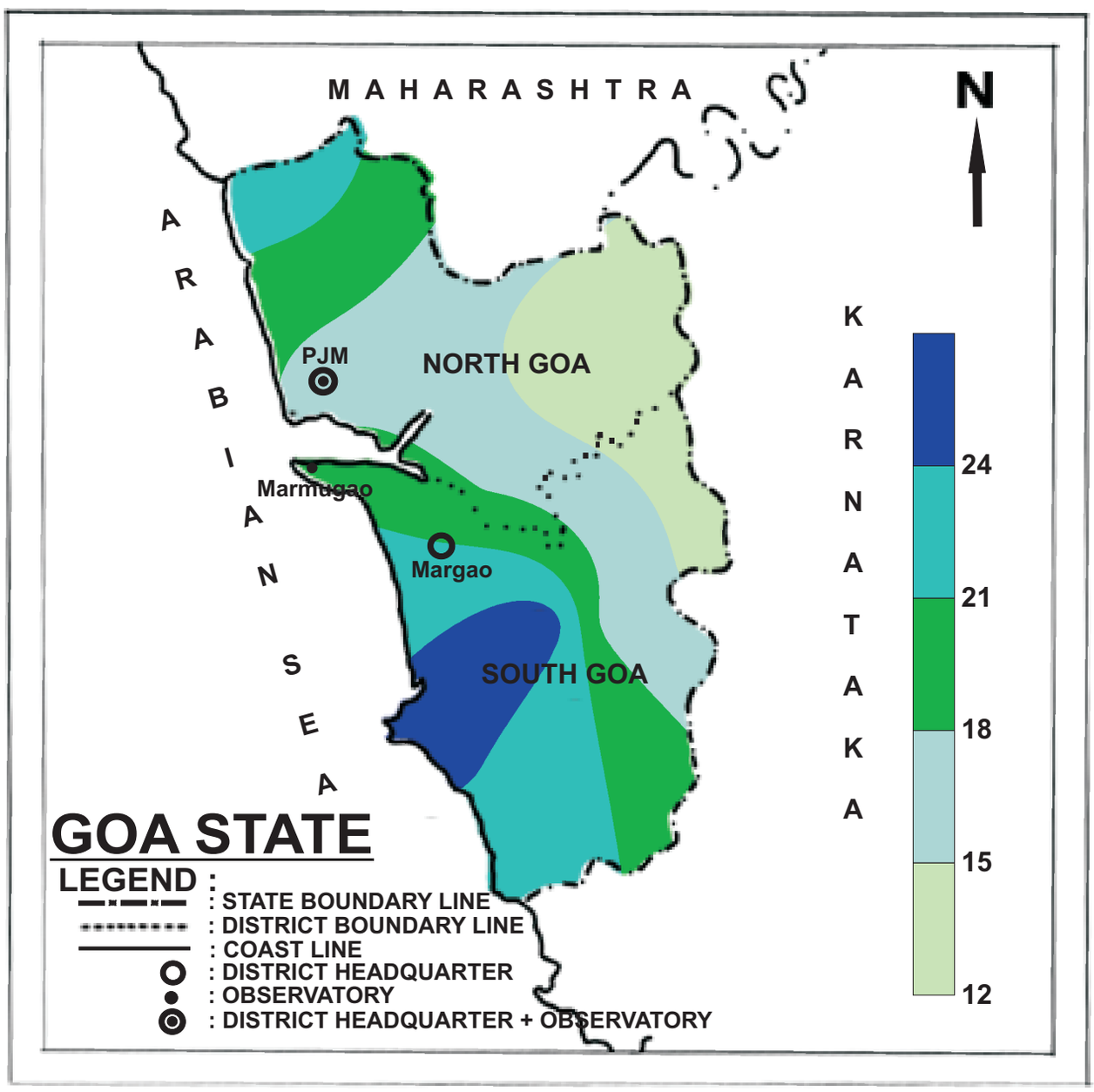

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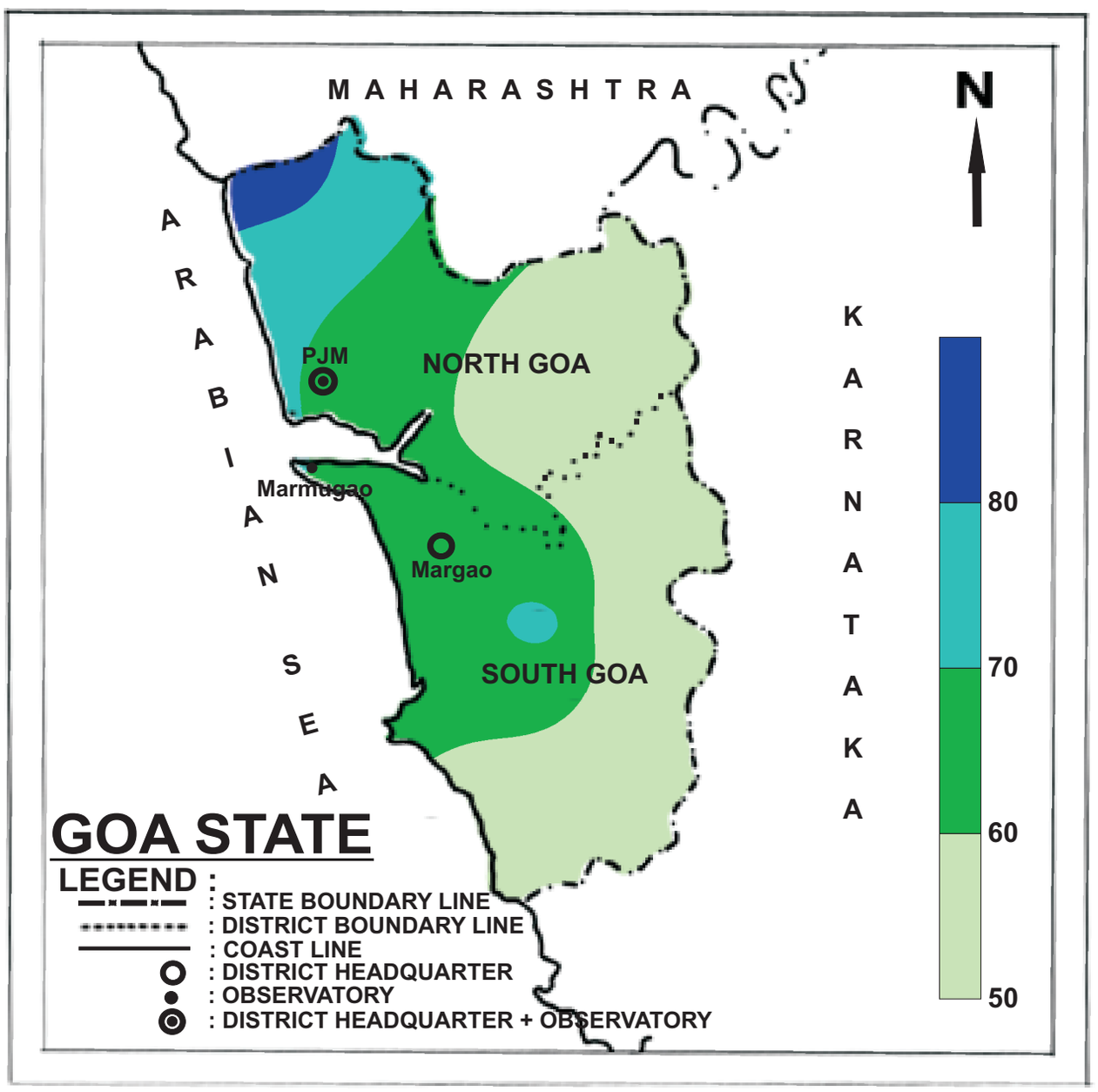

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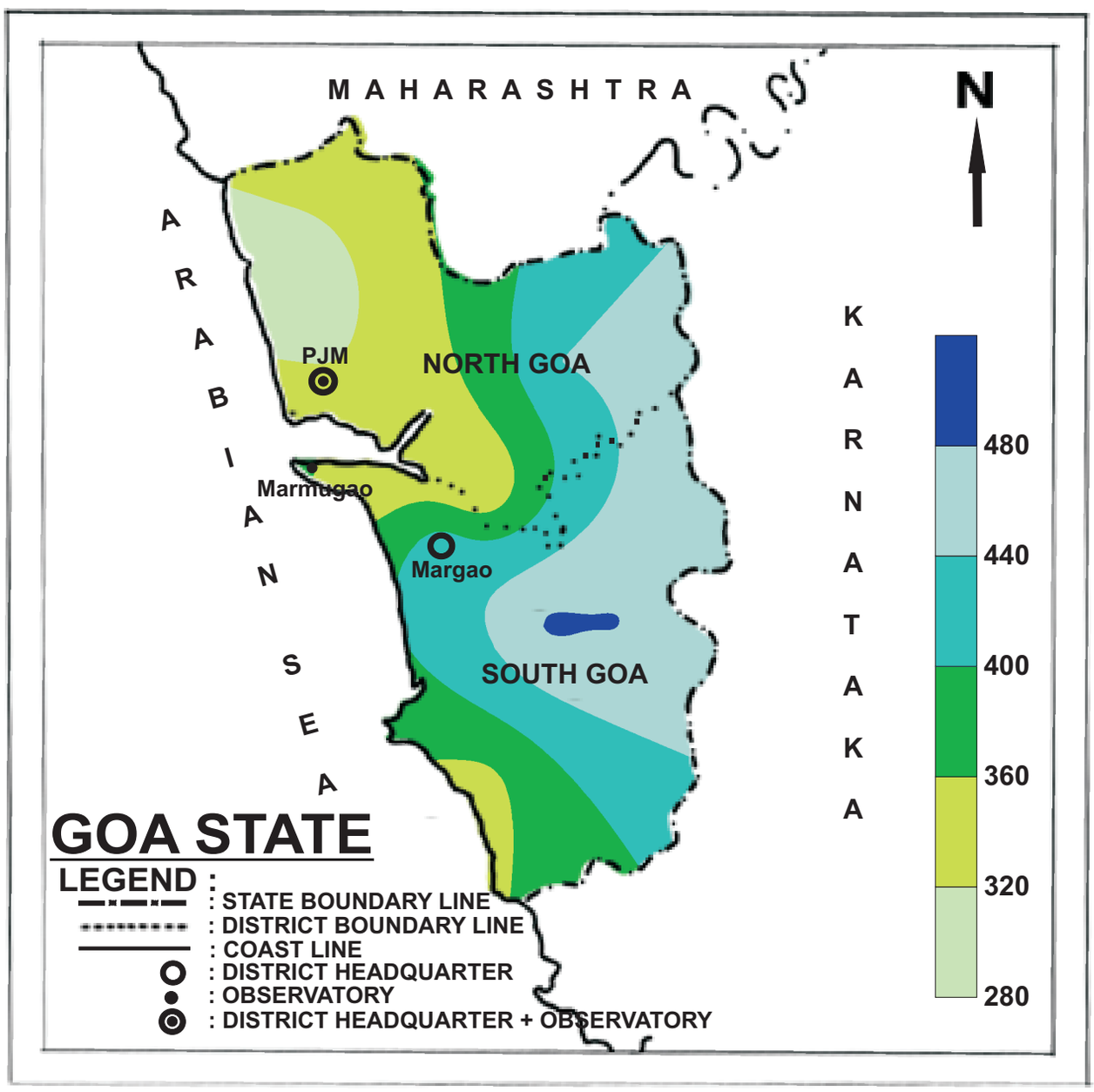

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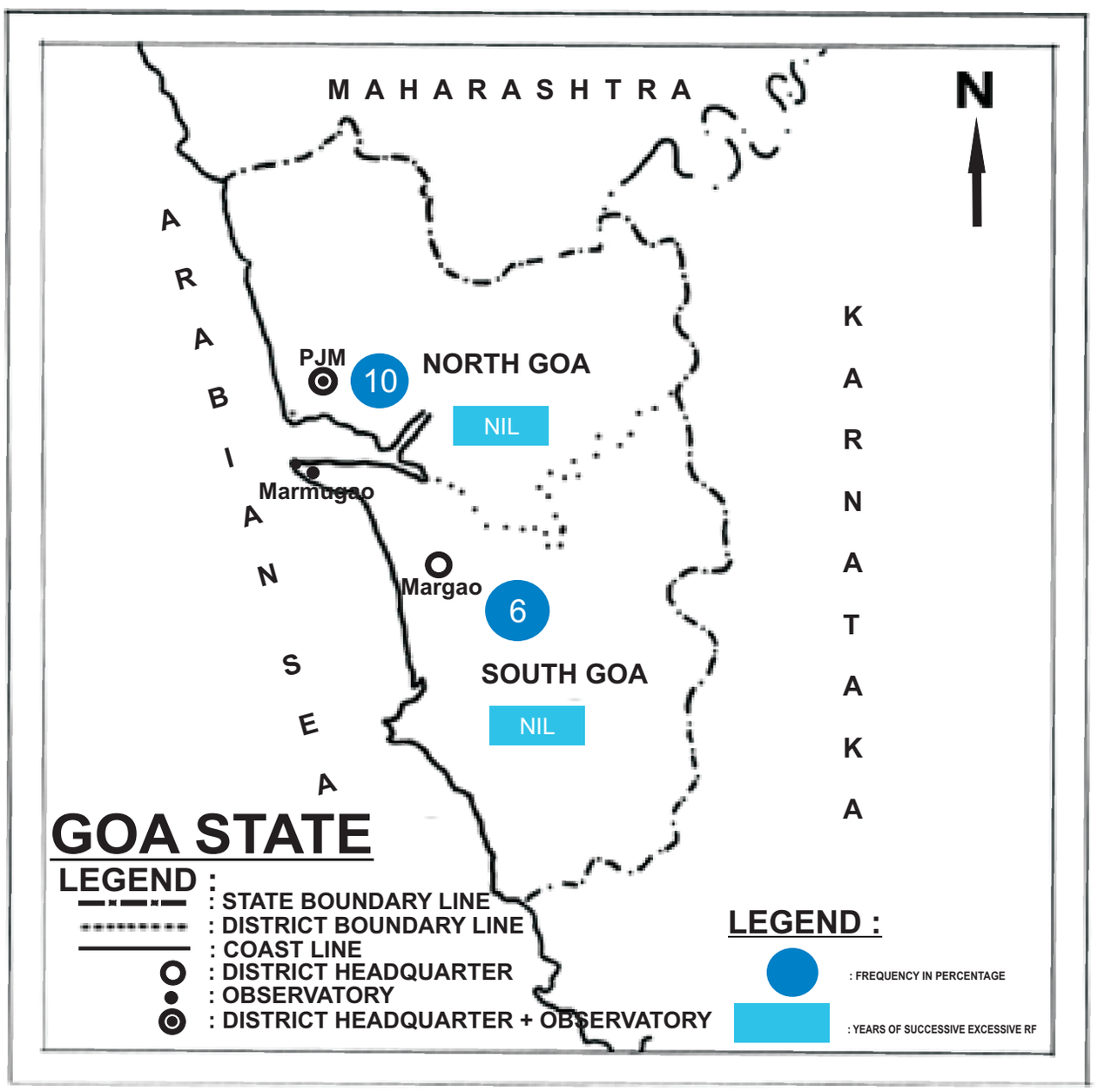

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STATE SUMMARY OF

GOA

CLIMATE OF GOA

Introduction

Goa is state, located on the western coast (Konkan coastal belt) of the Indian peninsula. Goa state is located between the co-ordinates14°53’57” N -15°47’59” N latitudes and 73°40’54”E-74°20’11”E longitudes. The geographical area of the state is 3,702 sq.kms. and it is bounded by Sindhudurg district of Maharashtra in the North, Belgavi and Dharwar districts of Karnataka along the East, Uttar Kannada district in the south and Arabian sea in the west. Most of the Goa is a part of the coastal region known as the Konkan, which an escarpment is raising upto the Western Ghats range of mountains, which separate it from the Deccan Plateau. The highest point is the Sonsogor, with an altitude of 1167 metres. Goa has a coastline of 101 Km. Goa can be divided into four different regions, the coastal plains with areas like Mormugao, Tiswadi, Salcete and Bardez. The Area of the Western Ghats like Sanguem, Sattari, Canacona and Ponda forms the Eastern Hilly region. The Flood Plains comprising of the rolling uplands and the coastal plains as well as the central valley lands consisting of the areas like Eastern Sanguem, Bicholim, Pernem and Quepem.

RIVERS

There are nine major rivers in Goa flowing from east (Western Ghats) to west (Arabian Sea) except Sal River. Terekhol, Chapora, Baga, Mandovi, Zuari, Sal, Saleri, Talpona and Galgibag are the main nine rivers of Goa. Among these rivers Mandovi and Zuari drain 2553 square km., about 70% of the total geographical area of Goa. Rivers in Goa are unique and are both tidal as well as rain fed.

Mandovi River: The Mandovi River has a length of 77 kms out of which 52 km is in Goa. It originates from a cluster of 30 springs at Bhimghat located in the Western Ghats of the Belgaum district in Karnataka. It enters Goa from the north through SattariTaluk is situated in the north eastern part of Goa. In the upper reaches of the river in Sattari valley the Mandovi River is referred to as the Mandei and it flows westward for 20 km. until it reaches Bembol where it merges with Khanderpar river. It then flows through Cumbarjua, Divadi and Chodne eventually

ending at the Arabian Sea. Khanderpar and Mapusa rivers are the main tributaries of Mandovi in Goa.

Zuari River: Zuari River is the largest river in Goa. It originates at Hemad-Barshem in the Western Ghats. It is a tidal river and is 92 km. long. The Zuari and Mandovi rivers form an estuarine system and are the backbone of Goa's agricultural industries. Both these rivers flush out into the Arabian Sea at Cabo Aguada, a common point forming the Mormugao harbor.

Chapora River: Chapora River is a river in northern Goa. It originates at Ramghat in the state of Maharashtra, enters Goa and flows westwards into the Arabian Sea at Chapora.

Terekhol River: Terekhol River is also known as the Banda River and originates in the Sahyadris in Maharashtra. It forms northern boundary of Goa state and separates it from Maharashtra state.

Sal River: Sal River is the third largest river in Goa (35 km.). It is the only river that flows a north - south direction before meeting the Arabian Sea at Betul.

Talpona River: Talpona River derives its name from the small fort in Canacona. It rises from Ambutghat and is a location for mangroves.

Galgibag River: Galgibag River originates in the state of Karnataka and flows into the Canacona taluka. The beautiful deserted beach stretch of Galgibag is a turtle nesting site for the endangered Olive Ridley turtles.

The state is a part of meteorological sub-division-Konkan and Goa and it has following 2 districts.

Sr. No.	District Name
1.	North Goa
2.	South Goa

Climate

Goa lies in the tropical zone and it is also bordered by the Arabian Sea on the west, it experiences hot and humid weather throughout the year. Although the climate is hot and humid, the temperature in Goa is always under control. Summer in Goa is not too hot and winter is not extremely cold. Goa has a moderate, typical monsoon climate with hot summers and chilly winters. For the rest of the year, the climate remains quite soothing. Monsoon is one of the main seasons of the state with July receiving the highest rainfall.

In general the year may be divided into four seasons. The months of January and February constitute the winter season. This is followed by the hot season which lasts till about the end of May. The period from June to September constitutes the southwest monsoon season. The three post monsoon months October, November and December constitute a transition period from the monsoon to winter conditions.

Areas in the state under each climate pattern based on Koppen's classification are shown in Fig.2. This broad classification is based on annual and monthly means of precipitation in cm and temperature in ^{0}C.

The state mainly comes under the climate type: Tropical monsoon, Hot; Seasonally excessive rainfall (Am).

Sea Level Pressure and Winds

The pressure gradient over the state generally remains weak except during late summer and monsoon season. The seasonal variation in atmospheric pressure over the state occurs in a systematic way with a maximum in the winter and minimum in southwest monsoon season. During winter the atmospheric pressure is high over north India and decreases to the south. Over Goa the pressure gradient is weak. Being coastal state, local winds (land breeze and Sea breeze) blow throughout the year except during southwest monsoon season when winds are predominantly southwesterly or westerly. Winds are mostly light to moderate and blow from west, northwest and southwest directions in the afternoon and in the

mornings winds mostly blow from east and northeast direction. Pressure thereafter decreases and by March it is nearly uniform over the state. During summer season winds are moderate and easterly to northeasterly winds are observed in the morning and in the afternoon westerly to northwesterly winds are seen and winds are strengthening towards evening. In April, with the establishment of a low over Bihar and adjoining parts of the country, a reversal in the pressure gradient occurs. The gradient over the state, however, continues to be weak. With the advance of the summer, seasonal low over north India deepens and shifts towards the northwest. Winds strengthen and mostly westerly to southwesterly are seen in the state from June to August. From September winds become moderate and easterly to northeasterly are observed in the morning and westerly, northwesterly and southwesterly are seen in the afternoon. October is the month of transition when reversal of pressure gradient takes place. Winds weaken and take a northerly component. The seasonal low begins to establish itself over the Bay of Bengal and conditions revert to the winter pattern. Pressure thereafter, continue to rise till January.

Table I gives the monthly mean wind speed in kilometer per hour and predominant wind direction in the morning and evening for observatory stations in the state.

Temperature

Table II gives the mean maximum and minimum temperatures at the observatory stations of the sub-division. The spatial distribution of mean maximum and mean minimum temperatures for the representative month of four seasons of year is depicted in Fig. 2(a,b,c,d) and 3(a.b.c.d).Fig. 4 and 5 give the extremes of maximum and minimum temperatures ever recorded on data up to 2015.

Pre-monsoon season is the hot period while winter is the cold period. April and May are the hottest months with mean maximum temperature about 33^0C and mean minimum temperature about 26^0C. Temperatures begin to fall with the onset of the southwest monsoon season in the first week of June. The drop in day temperatures after May till August is 3-4^0C over the state. The fall in night temperature is less rapid. After the withdrawal of the monsoon there is a tendency

for a rise in temperatures till November due to increased insolation. During winter period the night temperatures fall rapidly and day temperatures decrease slowly. January is the coldest month in the state with mean maximum temperature at about 32^0C and mean minimum temperature at about 21^0C. Both day and night temperatures then begin to rise slowly from March to May. Diurnal range of temperature is small during April to October being less than 8^0C due to maritime influence. It, however, increases to as much as 8 to 12^0C during November to March under the influence of northerly dry winds of land origin.

The mean annual range of temperature (i.e. the variation of the mean daily temperature through the year) is only 4 to 5^0C. Similarly, the mean change from the winter minimum (i.e. morning temperatures) to the summer maximum (i.e. afternoon temperatures) is about 12^0C.

The highest maximum temperature ever recorded at any individual station was 39.8^0C at Panjim observatory in North Goa district on 07th April 1989 which is about 7^0C higher than the normal for the warmest month. The lowest minimum temperature ever recorded in the state was 12.2^0C on 18th November 1946 at Marmugao observatory in South Goa district which is about 10^0C lower than the normal for the coldest month.

Both the maximum and minimum temperatures rise from March onwards till May. The increase in maximum temperature during the period from January to May ranges from about 1^0C to 2^0C at individual stations of the state. From June both day and night temperatures start to drop, the day temperature falls rapidly while night temperature falls slowly. From the beginning of June to the end of July the maximum and minimum temperatures fall by only about 1^0C to 2^0C.In September, a slight rise in the maximum temperature is experienced due to increased insolation. The night temperature starts to fall from October while the day temperature follows this trend from December and maximum temperature attains the lowest values in February while the minimum temperature attains the lowest values in January. The period from June to September has the smallest diurnal range of temperature about 5^0C - 6^0C. The diurnal range of temperature increases rapidly after withdrawal of southwest monsoon. During the period October to April diurnal range is of the order of 7^0C to 12^0C, being greatest in November to March.

The climate is pleasant from December to February. Summer months of April and May are uncomfortable with oppressive heat. The period of June to October is warm and humid, and uncomfortable.

Humidity

Table III gives the mean relative humidity at 0830 and 1730 hours IST for observatory stations in the state. Relative humidity is generally high throughout the year. Relative humidity is the highest during the southwest monsoon season i.e. the period from June to September when it ranges between 87% and 91% in the morning and 83% and 87% in the afternoon. In October also humidity is high at about 84% and 77% in the morning and afternoon respectively. Humidity decreases from November to May when it ranges from 71% to 79% in the morning and 61% to 71% in the afternoon. Morning humidity is generally higher than the afternoon humidity.

Cloudiness

Table IV and IV (a) give the mean monthly and total cloud amount and mean number of days with clear and overcast skies at 0830 and 1730 hours IST respectively for observatory stations in the state.

The skies are generally heavily clouded to overcast during southwest monsoon season from June to September when about 6 to 7 okta or above skies covered with clouds. The skies are moderately clouded during the months of October and May when about 5 okta skies covered with clouds. Skies are generally clear or lightly clouded during the period from November to April. Afternoons are however, comparatively more clouded than mornings.

Rainfall

Table V gives district wise and state wise mean monthly and annual rainfall and number of rainy days (i.e. days with rainfall of 2.5 mm or more). Fig. 6 and 6(a) to 6(d) depict the spatial distribution of the annual and seasonal rainfall over the state.

The normal annual precipitation for the state as a whole is about 337 cm and normal annual number of rainy days is about 103 (Table V). The precipitation in the state occurs in the form of rain. The spatial variation of annual rainfall is small as Goa state is having smaller geographical area. South Goa district receives at about 339 cm rainfall in a year while North Goa receives at about 335 cm of annual rainfall. Central and Southern parts of the state receive more rain.

Fig. 6(a) and 6(b) show rainfall pattern during winter (January and February)and pre-monsoon season (March to May) respectively. During these seasons the state receives very little amount of rain. State receives about 91% of annual rainfall during the southwest monsoon season. The pattern of spatial distribution of the rainfall during southwest monsoon season *viz.* Fig.6(c) generally resembles to that of the spatial distribution of the annual rainfall Fig. 6. Fig. 6(d) depicts spatial distribution of rainfall during post monsoon season, rainfall during this season contribute about 6.4% of the annual rainfall.

The percentage of the seasonal number of rainy days with respect to the annual number of rainy days shows that 86% during the southwest monsoon season, 3.6% during the pre-monsoon season, 0.5% during the winter season and 10% in post-monsoon season.

The state, is situated windward side of Western Ghats receives good amount of rainfall during southwest monsoon season. The state receives heavy rainfall during southwest monsoon season are known to be associated with offshore trough along west coast of India, low pressure areas and monsoon depressions originating in the Bay of Bengal, Arabian Sea during the southwest monsoon season. During the monsoon season most of the depressions originating in the Bay of Bengal cross inland and move westwards or west-north-westwards over the state. July is the rainiest month with 33% of the annual rainfall received in this month. It decreases rapidly after withdrawal of southwest monsoon in September. Precipitation during the

pre-monsoon months is mostly associated with thunderstorms and constitutes about 3.6% of the annual rainfall. The southwest monsoon sets in over the state by about the first week of June.

The monsoon withdraws from the state by about third week of September. The features of rainfall described above are also evident from Fig. 7 which shows the annual and seasonal rainfall for the individual districts as well as for the state and provides a measure for comparison of seasonal rainfall with the annual for both district wise and state wise rainfall.

Table VI gives the mean monthly and annual rainfall and rainy days for area covered by river catchment (No.102) in the state. River catchment No.102 formed by streams from the river Tadri to, but excluding, the Tapti which covers all districts of Goa state receives the annual rainfall about 3371 mm with 103 rainy days.

The annual rainfall of this river catchment in Goa state is shown in Fig.8.

Rainfall Variability

The spatial distribution of variation of annual rainfall over Goa is depicted in Fig. 9. Coefficient of Variation (CV) which is expressed as percentage is defined as:

$$C.V. = \frac{\text{Standard deviation } (\sigma)}{\text{Normal } (N)} \times 100$$

The spatial distribution of CV of seasonal rainfall over Goa is shown in Fig. 9(a), 9(b), 9(c) and 9(d) for the seasons: pre-monsoon season (March to May), southwest monsoon season (June to September), post monsoon season (October, November and December) and winter season (January and February) respectively

It is observed from Fig. 9 that values of CV of annual rainfall range between 13.4 % and 23.7 % over the entire state of Goa. Most part of the state is having CV ranging between 15% and 21%. Northeastern part of the state is having less variability with values ranging between 13% and 15%. Southwestern portion of the state is having the highest CV 21% to 23.7%.

During the pre-monsoon season, it is observed that values of CV range between 109.0% and 183.5% (Fig. 9(a)).Highest CV value is observed in northern most portion of North Goa district is ranging between 180% and 183%. Major portion

of the state is having CV values ranging between 120% and 140%. Southern part of the state is having lowest CV values ranging between 100% and 120%.

During southwest monsoon season, it is observed that values of rainfall variability CV ranges between 13.5 % and 25.7% (Fig. 9(b)). Northeastern part of the state is having less variability with values ranging between 13% and 15%. Southwestern portion of the state is having the highest CV 24% to 25.7%. Remaining part of the state is having CV values ranging between 15% and 24%.

During post monsoon season, the values of CV range between 52.8 % and 84.2% (Fig. 9(c)). Major eastern and southern part of the state is having CV values ranging between 52.8% and 60%. Highest CV value is observed in northern most portion of North Goa district is ranging between 80%.and 84.2%. Northwestern and central west part of the state exhibits CV values ranging between 70% and 80%. Central north to south part of the state shows CV values ranging between 60% and 70%.

During winter season, the values of CV range between 285.8 % and 485.1% (Fig. 9(d)). Northwestern and Southwestern part of the state exhibits CV values ranging between 285% and 360%. Some central, some southwestern and some northern portion of the state show CV values ranging between 360% and 440%. Eastern part of the state shows CV values ranging between 440% and 480%. Small portion of the state in central east part exhibits the highest CV values ranging between 480% and 485%.

As 91% of annual rainfall occurs during southwest monsoon season, the variability in this season over Goa state is relatively low and similar to that of annual rainfall while as the variability of rainfall during pre-monsoon and winter seasons are very high with CV values exceeding 109% and 285.8% respectively over the state. In general the contribution of rainfall during southwest monsoon season to the annual rainfall is a maximum over the state.

Excessive Rainfall:

Rainfall, sufficiently in excess of the normal, is a predominant factor for occurrence of floods, particularly in high rainfall regions. For the purpose of present

description, annual rainfall of 120% or more of the normal is considered as excessive rainfall.

Fig. 10 shows the percentage frequency of excessive rainfall years and successive years of excessive rainfall during the period 1961-2010.The following table (ii) gives the district wise excessive rainfall years and the highest annual rainfall (expressed as percentage of normal) with the years of occurrence.

Table (ii)

S.No.	District	Years of Excessive Rainfall	Highest Amount of Annual Rainfall in cm.(expressed as % of normal with year)			Annual Normal Rainfall In cm.
1	North Goa	1962,1983,1997, 1999,2010.	421.7	126 %	2010	334.7
2	South Goa	1961,2000.2010.	468.4	138 %	1961	339.4

From the above table, it is seen that during the period under consideration, there were 5 years in which North Goa district experienced excessive rainfall, while South Goa experienced excessive rainfall in 3 years. In year 2010 both the districts in the state recorded excessive rainfall. South Goa district received highest excessive rainfall, *i.e*. 138% of the annual normal rainfall in year 1961 and North Goa district received highest excessive rainfall, *i.e*. 126% of the annual normal rainfall in year 2010. The heaviest one day rainfall on record at any station in the state was 461.8 mm on 15 June1996 at Mapuca observatory in North Goa district.

Cyclonic storms and depressions

Table VII depicts the number of storms/depressions which affected the state during the period 1891- 2015. The cyclonic storms and depressions which affect the India mostly originate and/or intensify over the Bay of Bengal, mainly during the months of May to December. They usually travel northwestwards or westwards and cross the east coast of India. In general, storms and depressions weaken on

entering land. However, in association with these systems, heavy to very heavy rainfall occurs over the affected districts. In India most of the storms originate in the Bay of Bengal which affects the east coast of India. But the west coast of India is less affected as less number of storms and depressions originate in the Arabian Sea and Goa state is situated on the west coast of India so it is less affected.

During the period from January to September and in December the state has not been affected by the storm and depression for a single occasion. The number of storms / depressions that affected the state in October was 1 and in November it was 3.

During the period from 1891- 2017, only 4 storms/depressions affected the state.

Other Weather Phenomena

(a) Thunderstorms, Hail storms and Dust storms

Convective activity is responsible for the occurrence of thunderstorms, hailstorms and dust storms in Goa state. Thunderstorms generally occur throughout the year in the state. With the advance of the summer, thunderstorm activity becomes pronounced due to heating of the land. When the moisture in the atmosphere is insufficient, dry thunderstorms or dust storms occur. The maximum number of thunderstorms occurs with approach of the monsoon current, so its frequency reaches maximum in May, June, September and October. While dust storms are mainly confined to the summer and monsoon months. Monsoon thunderstorms are sometimes accompanied by squall. The average number of days of thunderstorms during the monsoon season and post monsoon season is ranging between 1 and 6 in the state and the maximum being in June. Thunderstorm activity is the least in the state during the winter months December to February. Dust storms rarely occur in the state during the post monsoon season.

(b) Fog

Favorable conditions for formation of fog such as light to calm wind, sufficient humidity, clear skies, low temperatures *etc*. do exist from September till April, maximum frequency of fog occurrence being during the months of January, February, September and October.

TABLE – I
MEAN WIND SPEED (KMPH) AND PREDOMINANT WIND DIRECTION
GOA

STATION		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
Panjim	a	7.3	7.8	7.9	8.7	9.4	11.5	12.8	10.8	7.5	6.8	6.7	7.0	8.7
	m	NE/E	E/NE	E/NE	NE/E/C/N	N/NW/NE/C	W/SW	W/SW	W/SW	C/E/NE	E/NE	E/NE	NE/E	
	e	W/NW	W/NW	W/NW	NW/W	W/NW	SW/W	W/SW	W/NW	NW/W	W/NW	W/NW	W/NW	
Marmugao	a	7.1	8.4	9.0	9.4	9.9	13.4	14.9	11.7	7.4	6.0	5.4	5.9	9.0
	m	NE/E	NE	NE	NE/N	N/NE/NW	SW	SW	SW/W	C	C/NE/E	E/NE	E/NE	
	e	NW/SW/W	NW	NW	NW	NW/W	SW	SW	SW/W	SW/NW/W	SW/W	SW/W/NW	SW/NW/W	
State Mean	**a**	**7.2**	**8.1**	**8.5**	**9.1**	**9.7**	**12.5**	**13.9**	**11.3**	**7.5**	**6.4**	**6.1**	**6.5**	**8.9**

a: Mean Wind Speed in Km. per hour.
m: Predominant Wind Direction in the Morning.
e: Predominant Wind Direction in the Evening.
C: Calm.

TABLE- II

MEAN MAXIMUM AND MINIMUM TEMPERATURE (^{O}C)

GOA

OBSERVATORY	TEMP	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Panjim	Max	32.4	32.2	32.3	33.1	33.6	30.6	29.2	29.1	30.1	31.8	33.2	32.9	31.7
	Min	20.2	20.7	23.3	25.3	26.4	24.9	24.3	24.1	24.1	24.0	22.6	20.9	23.4
Marmugao	Max	31.8	31.3	31.9	32.8	33.2	30.7	29.2	28.9	29.9	31.6	33.1	32.7	31.4
	Min	21.9	22.3	24.2	26.2	27.1	25.2	24.5	24.2	24.3	24.6	23.8	22.5	24.2
State Mean	**Max**	**32.1**	**31.7**	**32.1**	**32.9**	**33.4**	**30.7**	**29.2**	**29.0**	**30.0**	**31.7**	**33.1**	**32.8**	**31.5**
	Min	**21.1**	**21.5**	**23.7**	**25.7**	**26.7**	**25.1**	**24.4**	**24.1**	**24.2**	**24.3**	**23.2**	**21.7**	**23.8**

TABLE – III

MEAN RELATIVE HUMIDITY (%)

GOA

OBSERVATORY		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Panjim	M	79	80	81	76	75	88	91	91	91	86	77	74	82
	E	57	59	65	67	69	83	87	86	82	76	65	58	71
Marmugao	M	72	75	78	76	76	87	89	90	88	82	70	67	79
	E	64	67	71	71	73	84	86	87	83	78	67	63	74
State Mean	**M**	**75**	**77**	**79**	**76**	**75**	**87**	**90**	**91**	**89**	**84**	**73**	**71**	**81**
	E	**61**	**63**	**68**	**69**	**71**	**83**	**87**	**87**	**83**	**77**	**66**	**61**	**73**

M: MORNING E: EVENING

TABLE-IV

MEAN CLOUD AMOUNT ** (OKTA OF THE SKY) AND MEAN NUMBER OF DAYS OF CLEAR AND OVERCAST SKIES AT 0830 HRS. IST. GOA

OBSERVATORY		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Panjim	a	12	13	7	3	0	0	0	0	0	1	5	9	50
	b	0	0	0	1	3	14	19	15	8	4	1	0	65
	c	2.5	2.1	3.2	4.4	5.7	7.1	7.4	7.2	6.6	5.6	3.9	3.2	4.9
Mamugao	a	16	14	9	4	1	0	0	0	0	2	8	13	67
	b	0	0	0	0	2	12	16	12	7	3	1	0	53
	c	1.9	1.5	2.7	3.6	4.9	6.8	7.1	6.8	6.1	4.9	3.2	2.4	4.3
State Mean	**a**	**14**	**13**	**8**	**3**	**1**	**0**	**0**	**0**	**0**	**1**	**7**	**11**	**58**
	b	**0**	**0**	**0**	**1**	**3**	**13**	**17**	**13**	**7**	**3**	**1**	**0**	**58**
	c	**2.2**	**1.8**	**2.9**	**4.0**	**5.3**	**6.9**	**7.3**	**7.0**	**6.3**	**5.3**	**3.5**	**2.8**	**4.6**

a: Days with clear sky.
b: Days with sky overcast.
c: Mean Cloud Amount.
** = Unit, equal to one eighth of sky used in specifying cloud amount.
For example: 1 Okta means 1/8th of the sky covered.

TABLE IV (A)

MEAN CLOUD AMOUNT ** (OKTA OF THE SKY) AND MEAN NUMBER OF DAYS OF CLEAR AND OVERCAST SKIES AT 1730 HRS.IST GOA

OBSERVATORY		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Panjim	a	13	15	9	4	1	0	0	0	0	1	5	7	55
	b	0	0	0	0	2	14	19	14	8	5	2	1	65
	c	2.4	1.7	2.8	3.8	5.0	7.0	7.4	7.1	6.5	5.7	4.2	3.3	4.7
Marmugao	a	15	18	12	6	1	0	0	0	0	2	7	11	72
	b	0	0	0	0	1	12	17	14	6	4	1	1	56
	c	1.8	1.1	2.1	2.9	4.3	6.8	7.2	6.9	6.1	5.2	3.5	2.5	4.2
State Mean	**a**	**14**	**17**	**11**	**5**	**1**	**0**	**0**	**0**	**0**	**1**	**6**	**9**	**64**
	b	**0**	**0**	**0**	**0**	**1**	**13**	**18**	**14**	**7**	**5**	**1**	**1**	**60**
	c	**2.1**	**1.4**	**2.5**	**3.3**	**4.7**	**6.9**	**7.3**	**7.0**	**6.3**	**5.5**	**3.9**	**2.9**	**4.5**

a : Days with clear sky.
b : Days with sky overcast.
c : Mean Cloud amount
** = Unit, equal to one eighth of the sky used in specifying cloud amount
For example: 1 Okta means 1/8th of the sky covered.

TABLE- V

MEAN RAINFALL (in mm) AND NUMBER OF RAINY DAYS
GOA

DISTRICTS		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
North Goa	a	0.6	0.1	2.8	5.6	70.4	928.1	1108.9	706.0	315.1	160.0	39.7	9.8	3347.1
	b	0.1	0.0	0.1	0.4	3.2	21.8	27.5	25.0	14.3	7.1	2.4	0.4	102.3
South Goa	a	1.8	0.0	2.9	7.6	92.2	888.8	1128.0	709.5	340.0	171.6	38.5	13.3	3394.2
	b	0.1	0.0	0.1	0.5	3.1	21.9	27.1	24.7	14.8	7.9	2.0	0.6	102.8
State Mean	**a**	**1.2**	**0.1**	**2.9**	**6.6**	**81.3**	**908.5**	**1118.5**	**707.7**	**327.5**	**165.8**	**39.1**	**11.5**	**3370.7**
	b	**0.1**	**0.0**	**0.1**	**0.5**	**3.1**	**21.9**	**27.3**	**24.9**	**14.5**	**7.5**	**2.2**	**0.5**	**102.5**

a :- Normal Rainfall (mm)
b:- Average number of rainy days (i.e. days with rainfall of 2.5 mm or more).

TABLE-VI

MEAN RAINFALL(mm) OVER PART OF RIVER CATCHMENT NO.102 WITHIN GOA STATE

Sr.No	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1)	River Tadri to, but excluding , the Tapti (PART OF Catchment No. 102 WITHIN GOA STATE)												
	North Goa and South Goa districts												
a	1.2	0.1	2.9	6.6	81.3	908.5	1118.5	707.7	327.5	165.8	39.1	11.5	3370.7
b	0.1	0.0	0.1	0.5	3.1	21.9	27.3	24.9	14.5	7.5	2.2	0.5	102.5

a: Normal Rainfall in mm.
b: Average number of rainy days.

TABLE – VII

STORMS AND DEPRESSIONS AFFECTING GOA STATE DURING 1891 – 2017

MONTHS	NO. OF STORMS/ DEPRESSIONS
JANUARY	NIL
FEBRUARY	NIL
MARCH	NIL
APRIL	NIL
MAY	NIL
JUNE	NIL
JULY	NIL
AUGUST	NIL
SEPTEMBER	NIL
OCTOBER	1
NOVEMBER	3
DECEMBER	NIL
TOTAL	**4**

DISTRICT SUMMARIES OF

GOA

NORTH GOA

North Goa, district of Goa state is a part of the West coast region of India, has many physical features that are common to neighboring regions of Maharashtra and Karnataka states. But the features that land the landscape and scenery of Goa a distinctive charm of their own, are the Sahyadri in the east. The territory, which is situated well within the tropics and flanked by the Arabian Sea to the west and the Western Ghats (Sahyadri) rising to an average height of 1 km. to the east, has tropical maritime and monsoon type climate, with profound orographic influence. Due to proximity of the Sea, the territory is generally humid, with a further rise in humidity during the monsoon season.

Generally the year may be divided into four seasons. The period of March to May is of pre-monsoon season followed by the southwest monsoon from June to September. The period of October to December constitutes the post monsoon season or transition period between monsoon and winter season. The period from January to February is the winter season.

RAINFALL

Records of rainfall in the district are available for five rain gauge stations for the period ranging from 18 to 50 years. The details of rainfall for these stations and for the district as a whole are given in Table 1 and 2. The average annual rainfall in the district is 3347.1 mm. Rainfall varies from place to place due to topographic variation in the district. However, rainfall increases from west towards the eastern part of the district. June to September comprising of southwest monsoon season is a chief rainy bearing period which constitutes about 91% of the annual rainfall. July is the rainiest month in the year with an average rainfall of about 1109 mm. During the period 1961-2010 the highest annual rainfall occurred in the year 2010 when it amounted to 126% of the normal. However, the lowest annual rainfall which was 55% of the normal occurred in 1972. In this period there were 9 years in which the rainfall was less than 80% of the normal and during this period there were three

occasions of two consecutive years. It is seen from Table 2 that the annual rainfall in the district was between 2601 mm and 4100 mm in 39 years out of 49.

On an average there are about 102 rainy days (i.e. days with rainfall of 2.5 mm or more) in a year in the district. The heaviest rainfall recorded in 24 hours in the district was 461.8 mm at Mapuca observatory on 15 June 1996.

TEMPERATURE

There are 5 meteorological observatories in the district but data of Panjim observatory situated at an altitude of 60 metre is available for sufficient long period so the description which follows is based on the records of this observatory. Being a coastal district, the variation of day temperatures throughout the year is not large. In the hot season, temperatures rise slowly from March to May which is the hottest month with mean maximum temperature at 33.6°C and mean minimum temperature at 26.4°C. Day temperatures during the monsoon are low than those in the winter season. In the post monsoon months October, November and December, day temperatures increase and days in November are as hot as in April and May. Night temperature is the lowest in December, January and February which is at about 21°C. Areas within 20 to 25 kilometers of the coast are the most pleasant, particularly in the hot months with the sea breeze blowing, nearly throughout the day hours. Further inland, during the hot months both days and nights are oppressive in the tract at the foot of the Western Ghats. Along the coast maximum temperatures rarely go beyond 38°C.

The highest maximum temperature ever recorded at Panjim was 39.8°C on 07thApril 1989 and the lowest minimum was 13.3°C on 28th February 1965.

HUMIDITY

Owing to the proximity of the sea, the district is on the whole very humid. Humidity is generally on an average about 82% in the morning and about

71% in the afternoon. Morning humidity is more than the afternoon humidity. The relative humidity is the highest in the monsoon season when it is about 91% in the morning and about 84% in the afternoon. November to May is the period of slightly less humid with afternoon humidity is about 63%.

CLOUDINESS

Skies are generally heavily clouded to overcast during the southwest monsoon season and lightly to moderately cloud in the rest of the year. In the southwest monsoon season skies are heavily clouded with cloud amount at about 7 okta or more in the district. The cloudiness decreases from October.

WINDS

Winds are generally moderate to strong throughout the year. Winds are strong in the monsoon months June to August and are mainly blow from southwest and west along with some north westerly's in the afternoon of August. In the rest of the year winds generally blow from east and northeast in the mornings and from west and northwest in the afternoons.

SPECIAL WEATHER PHENOMENA

Thunderstorms generally occur throughout the year and its frequency is more during the period from May to October. Minimum frequency is observed during winter season. Fog generally occurs during the period from August to April.

Tables 3, 4, 5 and 6 give the normal of temperature and humidity, cloudiness, wind speed and direction and special weather phenomena respectively for Panjim observatory.

TABLE - 1
NORMALS AND EXTREMES OF RAINFALL
NORTH GOA

STATION	No. of Years of Data		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	ANNUAL RAINFALL AS % OF NORMAL & YEARS**		HEAVIEST RAINFALL IN 24 HOURS*	
																HIGHEST	LOWEST	AMOUNT (mm)	DATE
Mapuca Obsy	38	a b	0.8 0.2	0.0 0.0	1.8 0.1	3.4 0.2	57.8 3.1	904.0 21.5	983.2 26.8	587.5 23.9	256.8 12.9	124.1 5.4	32.1 2.0	15.8 0.4	2967.3 96.5	137 (1983)	66 (1986)	461.8	15 Jun 1996
Panjim Obsy	50	a b	0.5 0.1	0.1 0.0	2.1 0.1	6.3 0.5	96.7 3.8	873.8 21.5	926.1 26.1	573.9 23.4	262.1 13.0	130.7 6.0	28.9 2.3	12.0 0.4	2913.2 97.2	148 (1961)	59 (1986)	366.6	12 Jun 1999
Pernem Obsy	18	a b	0.6 0.1	0.0 0.0	0.2 0.1	3.3 0.3	30.2 1.9	952.8 21.3	1138.5 27.9	618.5 23.5	322.2 14.3	164.1 6.8	44.3 2.4	1.4 0.3	3276.1 98.9	137 (2010)	62 (1986)	389.9	20 Aug 1937
Ponda obsy	42	a b	0.6 0.1	0.2 0.0	4.8 0.1	6.3 0.4	88.3 3.7	940.9 21.9	1124.2 27.6	735.3 26.0	311.9 14.2	175.2 8.1	35.7 2.4	8.6 0.4	3432.0 104.9	149 (1961)	56 (1986)	363.8	16 Jun 1992
Valpoi obsy	40	a b	0.7 0.1	0.0 0.0	4.9 0.3	8.5 0.8	79.2 3.7	968.9 22.7	1372.3 29.2	1014.6 28.0	422.3 16.9	205.8 9.1	57.6 2.7	11.3 0.5	4146.1 114.0	143 (1961)	75 (1986)	402.3	20 Aug 1952
North Goa (District)		**a** **b**	**0.6** **0.1**	**0.1** **0.0**	**2.8** **0.1**	**5.6** **0.4**	**70.4** **3.2**	**928.1** **21.8**	**1108.9** **27.5**	**706.0** **25.0**	**315.1** **14.3**	**160.0** **7.1**	**39.7** **2.4**	**9.8** **0.4**	**3347.1** **102.3**	**126** **(2010)**	**55** **(1972)**		

a: Normal rainfall in mm.
b: Average number of rainy days (i.e. days with rainfall of 2.5 mm or more).
*** Based on all available data upto 2012.**
**** Years of occurrence given in brackets.**

TABLE - 2
FREQUENCY OF ANNUAL R/F IN THE DISTRICT
(DATA 1961 - 2010)
NORTH GOA

RANGE IN MM	NO. OF YEARS	RANGE IN MM	NO.OF YEARS	RANGE IN MM	NO. OF YEARS
1801 - 1900	1	2601 - 2700	3	3401 - 3500	0
1901 - 2000	0	2701 - 2800	2	3501 - 3600	4
2001 - 2100	0	2801 - 2900	1	3601 - 3700	1
2101 - 2200	1	2901 - 3000	2	3701 - 3800	1
2201 - 2300	1	3001 - 3100	5	3801 - 3900	2
2301 - 2400	0	3101 - 3200	7	3901- 4000	2
2401 - 2500	1	3201 - 3300	3	4001- 4100	2
2501 - 2600	3	3301 - 3400	4	4101- 4200	2
				4201- 4300	1

(Data available for 49 years)

TABLE – 3
NORMALS OF TEMPERATURE AND RELATIVE HUMIDITY
(PANJIM)

MONTH	Mean Maximum Temperature	Mean Minimum Temperature	Highest Maximum ever recorded		Lowest Minimum ever recorded		Relative Humidity (%)	
	^{0}C	^{0}C	^{0}C	Date	^{0}C	Date	0830 IST	1730 IST
January	32.4	20.2	36.7	22-01- 2011	14.4	03-01-1991	79	57
February	32.2	20.7	39.2	20-02- 2009	13.3	28-02-1965	80	59
March	32.3	23.3	39.0	12-03-1979	17.5	06-03-1971	81	65
April	33.1	25.3	39.8	07-04-1989	19.4	01-04-1905	76	67
May	33.6	26.4	38.6	06-05-2004	20.9	01-05-1995	75	69
June	30.6	24.9	37.8	14-06-2006	20.7	22-06-1992	88	83
July	29.2	24.3	32.5	11-07-2015	20.5	0-07-1912	91	87
August	29.1	24.1	34.0	14-08-1965	21.7	31-08-1988	91	86
September	30.1	24.1	33.4	30-09-2015	21.0	27-09-1964	91	82
October	31.8	24.0	37.2	15-10-2008	20.0	30-10-2010	86	76
November	33.2	22.6	37.2	05-11-1988	15.3	29-11-1964	77	65
December	32.9	20.9	36.6	14-12-2006	15.7	12-12-1981	74	58
Annual	31.7	23.4	39.8	07-04-1989	13.3	28-02-1965	82	71

TABLE – 4

MEAN CLOUD AMOUNT **(OKTA OF THE SKY) AND MEAN NUMBER

OF DAYS OF CLEAR AND OVERCAST SKIES

(PANJIM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0830 HOURS IST													
a	12	13	7	3	0	0	0	0	0	1	5	9	50
b	0	0	0	1	3	14	19	15	8	4	1	0	65
c	2.5	2.1	3.2	4.4	5.7	7.1	7.4	7.2	6.6	5.6	3.9	3.2	4.9
1730 HOURS IST													
a	13	15	9	4	1	0	0	0	0	1	5	7	55
b	0	0	0	0	2	14	19	14	8	5	2	1	65
c	2.4	1.7	2.8	3.8	5.0	7.0	7.4	7.1	6.5	5.7	4.2	3.3	4.7

a: Days with clear sky.
b: Days with sky overcast.
c: Mean cloud amount in Okta.
**** Okta = Unit equal to area of one eighth of the sky used in specifying cloud amount. For example: 1 Okta means 1/8th of the sky covered.**

TABLE - 5
MEAN WIND SPEED AND PREDOMINANT WIND DIRECTION
(PANJIM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Wind Speed in Km/hr	7.3	7.8	7.9	8.7	9.4	11.5	12.8	10.8	7.5	6.8	6.7	7.0	8.7
Direction in morning	NE/E	E/NE	E/NE	NE/E/C/N	N/NW/NE/C	W/SW	W/SW	W/SW	C/E/NE	E/NE	E/NE	NE/E	
Direction in evening	W/NW	W/NW	W/NW	NW/W	W/NW	SW/W	W/SW	W/NW	NW/W	W/NW	W/NW	W/NW	

TABLE - 6
SPECIAL WEATHER PHENOMENA
(PANJIM)

Mean No. of Days With	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Thunder	0.1	0.0	0.4	1.0	3.3	6.1	1.3	0.5	2.8	5.2	1.3	0.1	22.1
Hail	0	0	0	0	0	0	0	0	0	0	0	0	0
Dust storm	0	0	0	0	0	0	0	0	0	0	0	0	0
Fog	1.2	1.6	1.5	0.1	0	0	0	0.3	2.6	4.7	1.1	0.2	13.3

SOUTH GOA

South Goa district is a part of the west coast region of India. Geographically the district has mainly three natural division's namely Low land, the Plateaus and the Mountain region.

South Goa district of Goa state covers the entire southern part of Goa. Arabian Sea is to the west of district, North Goa district to the North and Uttar Kannada district of Karnataka in the East and South, Sahyadri mountains are the east of South Goa. The climate of South Goa is generally hot as it lies within the tropics.

Generally the year may be divided into four seasons. The period of March to May is of pre-monsoon season followed by the southwest monsoon from June to September. The rainfall is more in the mountainous region than coastal region. The period of October to December constitute the post monsoon season or transition period between monsoon and winter season. The period of January and February is the winter or cold season.

RAINFALL

Records of rainfall in the district are available for seven rain gauge stations for the period ranging from 10 to 47 years. The details of rainfall for these stations and for the district as a whole are given in Table 1 and 2. The average annual rainfall in the district is 3394.2 mm. Rainfall varies from place to place due to topographic variation in the district. However, rainfall increases towards the northern part of the district. June to September comprising of southwest monsoon season is a chief rain bearing period which constitutes about 90% of the annual rainfall. July is the rainiest month in the year with an average rainfall of about 1128.0 mm. During the period of October to February the district receives only about 6% of the annual rainfall. During the period 1961- 2010 the highest annual rainfall occurred in the year 1961 when it amounted to 138% of the normal. However, the lowest annual rainfall was 48% of the normal occurred in 1972. In this period there were 15 years in which the rainfall was less than 80% of the normal and such a low rainfall occurred in two consecutive

years twice and three consecutive years once. It is seen from Table 2 that the annual rainfall in the district was between 2701 mm and 4100 mm in 33 years out of 50.

On an average there are about 103 rainy days (i.e. days with rainfall of 2.5 mm or more) in a year in the district. The heaviest rainfall recorded in 24 hours in the district was 432.6 mm at Sanguem observatory on 07th Jun 1909.

TEMPERATURE

There is a meteorological observatory in the district at Marmugao situated at an altitude of 62 metre so the description which follows is based on the records of this observatory. Being a coastal district, the diurnal variation of temperatures during the day throughout the seasons is nearly same. In the hot season, temperatures rise slowly from March to May which is the hottest month with mean maximum temperature at 33.2°C and mean minimum temperature at 27.1°C. Day temperatures during the monsoon are lower than those in the winter season. In the post monsoon months October, November and December, day temperatures increase and days in November are as hot as in May. Night temperatures are the lowest in January. Further inland, during the hot months both days and nights are oppressive in the tract at the foot of the Western Ghats. Along the coast maximum temperatures rarely go beyond 38°C.

The highest maximum temperature ever recorded at Marmugao was 38.4°C on 7th May 2004 and the lowest minimum was 12.2°C on 18th November 1946.

HUMIDITY

Owing to the proximity of the sea, the district is on the whole very humid. Humidity is generally about 79 % in the morning and about 75% in the afternoon. Morning humidity is more than the afternoon humidity throughout the year. The relative humidity is the highest in the monsoon season when it is about 89% in the morning and about 85% in the afternoon. November to April is the period of

slightly less humid with morning humidity about 73% and afternoon humidity is about 67%.

CLOUDINESS

Skies are generally heavily clouded to overcast during the southwest monsoon season and lightly to moderately clouded in the rest of the year. In the southwest monsoon season skies are heavily clouded with cloud amount at about 7 okta in the district. The cloudiness decreases from November.

WINDS

Winds are generally moderate to strong throughout the year. Winds are strong in the monsoon months (June to August) and are mainly blow from southwest and west. In the rest of the year winds generally blow from east and northeast in the mornings. Winds generally blow from west and northwest in the afternoons during the period from January to May and from southwest, west and northwest during the period from September to December.

SPECIAL WEATHER PHENOMENA

Thunderstorms generally occur throughout the year and its frequency is more during the period from May to October. Minimum frequency is observed during winter season. Fog generally occurs during the period from September to April.

Tables 3, 4, 5 and 6 give the normal of temperature and humidity, cloudiness, wind speed and direction and special weather phenomena respectively for Marmugao observatory.

TABLE - 1
NORMALS AND EXTREMES OF RAINFALL
SOUTH GOA

STATION	No. of Years of Data		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	ANNUAL RAINFALL AS % OF NORMAL & YEARS**		HEAVIEST RAINFALL IN 24 HOURS*	
																HIGHEST	LOWEST	AMOUNT (mm)	DATE
Canacona Obsy	17	a	1.4	0.0	0.0	3.0	148.4	935.2	944.0	635.2	311.3	219.2	71.4	22.2	3291.3	139	71	298.7	1 Jul 1942
		b	0.1	0.0	0.0	0.3	3.3	22.2	25.2	24.4	14.4	9.4	2.5	1.1	102.9	(1961)	(1966)		
Colem Obsy	10	a	0.0	0.0	0.0	19.7	92.3	911.1	1790.5	930.0	597.5	207.1	36.6	19.3	4604.1	120	90	300.0	20 Jul 1965
		b	0.0	0.0	0.0	0.9	2.5	24.1	30.2	27.7	20.8	10.3	1.6	1.1	119.2	(1974)	(1964)		
Dabolim N.A.S. Obsy	44	a	2.2	0.2	1.8	5.2	89.6	803.1	846.1	529.1	300.8	125.5	31.4	7.7	2742.7	136	63	330.7	15 Jun 1996
		b	0.1	0.0	0.2	0.5	2.9	20.8	25.1	22.1	12.9	5.9	2.0	0.4	92.9	(1996)	(1972)		
Margaon obsy	41	a	1.0	0.0	3.7	5.4	94.0	871.9	1007.3	641.0	267.3	147.4	24.8	13.7	3077.5	156	66	350.1	12 Jun 1999
		b	0.1	0.0	0.2	0.4	3.4	21.2	27.1	23.6	13.6	6.8	1.6	0.4	98.4	(1961)	(1986)		
Marmugao obsy	47	a	1.6	0.1	2.0	4.6	85.5	801.3	825.7	512.7	262.0	118.2	33.3	9.5	2656.5	134	57	368.0	12Jun 1999
		b	0.1	0.0	0.1	0.3	3.4	20.7	25.3	22.6	13.0	5.5	2.0	0.4	93.4	(2010)	(1972)		
Quepem obsy	37	a	0.9	0.0	6.3	7.3	87.7	1013.6	1252.4	862.1	331.7	192.8	34.5	13.0	3802.3	185	71	390.6	12 Jun 1999
		b	0.0	0.0	0.2	0.4	4.0	22.5	28.3	26.1	14.2	8.8	1.9	0.4	106.8	(1970)	(2004)		
Sanguem obsy	39	a	5.5	0.0	6.2	7.8	48.1	885.4	1229.7	856.7	309.6	191.2	37.2	7.9	3585.3	133	71	432.6	7 Jun 1909
		b	0.1	0.0	0.2	0.6	2.5	21.7	28.6	26.6	14.6	8.3	2.1	0.4	105.7	(2010)	(1964)		
South Goa (District))		**a**	**1.8**	**0.0**	**2.9**	**7.6**	**92.2**	**888.8**	**1128.0**	**709.5**	**340.0**	**171.6**	**38.5**	**13.3**	**3394.2**	**138**	**48**		
		b	**0.1**	**0.0**	**0.1**	**0.5**	**3.1**	**21.9**	**27.1**	**24.7**	**14.8**	**7.9**	**2.0**	**0.6**	**102.8**	**(1961)**	**(1972)**		

a: Normal rainfall in mm.
b: Average number of rainy days (i.e. days with rainfall of 2.5 mm or more).
* Based on all available data upto 2015.
** Years of occurrence given in brackets.

TABLE - 2
FREQUENCY OF ANNUAL R/F IN THE DISTRICT
(DATA 1961 - 2010)
SOUTH GOA

	NO. OF YEARS	RANGE IN MM	NO.OF YEARS	RANGE IN MM	NO. OF YEARS
1601 - 1700	1	2701 - 2800	0	3801 - 3900	0
1701 - 1800	0	2801 - 2900	5	3901- 4000	2
1801 - 1900	0	2901 - 3000	2	4001- 4100	1
1901 - 2000	0	3001 - 3100	4	4101- 4200	2
2001 - 2100	0	3101 - 3200	6	4201- 4300	0
2101 - 2200	2	3201 - 3300	3	4301- 4400	0
2201 - 2300	0	3301 - 3400	2	4401- 4500	0
2301 - 2400	1	3401- 3500	3	4501- 4600	0
2401- 2500	4	3501- 3600	1	4601- 4700	1
2501- 2600	3	3601 - 3700	3		
2601 - 2700	3	3701 - 3800	1		

(Data available for 50 years**)**

TABLE- 3

NORMALS OF TEMPERATURES AND RELATIVE HUMIDITY
MARMUGAO

MONTH	MEAN MAXIMUM TEMP	MEAN MINIMUM TEMP	HIGHEST MAXIMUM EVER RECORDE D		LOWEST MINIMUM EVER RECORDED		RELATIVE HUMIDITY (%)	
	^{0}C	^{0}C	^{0}C	DATE	^{0}C	DATE	0830	1730
JANUARY	31.8	21.9	36.1	27-01-1993	16.7	07-01-1945	72	64
FEBRUARY	31.3	22.3	37.8	29-02-1984	17.2	10-02-1944	75	67
MARCH	31.9	24.2	38.0	26-03-2006	17.3	01-03-2004	78	71
APRIL	32.8	26.2	37.8	06-04-1997	20.6	05-04-1953	76	71
MAY	33.2	27.1	38.4	07-05-2004	20.7	02-05-1971	76	73
JUNE	30.7	25.2	35.6	06-06-2012	17.0	10-06-1964	87	84
JULY	29.2	24.5	32.7	02-07-1982	20.2	21-07-1965	89	86
AUGUST	28.9	24.2	32.5	01-08-1987	19.3	07-08-1964	90	87
SEPTEMBER	29.9	24.3	36.5	03-09-2006	21.1	19-09-1946	88	83
OCTOMBER	31.6	24.6	36.8	16-10-2008	18.3	30-10-1932	82	78
NOVEMBER	33.1	23.8	36.7	24-11-2000	12.2	18-11-1946	70	67
DECEMBER	32.7	22.5	37.7	30-12-1995	17.2	01-12-1955	67	63
ANNUAL	31.4	24.2	38.4	07-05-2004	12.2	18-11-1946	79	74

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TABLE - 4

MEAN CLOUD AMOUNT ** (OKTA OF THE SKY) AND MEAN NUMBER

OF DAYS OF CLEAR AND OVERCAST SKIES.

MARMUGAO

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
0830 HOURS IST													
a	16	14	9	4	1	0	0	0	0	2	8	13	67
b	0	0	0	0	2	12	16	12	7	3	1	0	53
c	1.9	1.5	2.7	3.6	4.9	6.8	7.1	6.8	6.1	4.9	3.2	2.4	4.3
1730 HOURS IST													
a	15	18	12	6	1	0	0	0	0	2	7	11	72
b	0	0	0	0	1	12	17	14	6	4	1	1	56
c	1.8	1.1	2.1	2.9	4.3	6.8	7.2	6.9	6.1	5.2	3.5	2.5	4.2

a : Days with clear sky.

b : Days with sky overcast.

c :Mean Cloud amount.

** Okta = Unit, equal to one eighth of the sky used in specifying cloud amount

For example: 1 Okta means $1/8^{th}$ of the sky covered.

TABLE - 5

MEAN WIND SPEED (KMPH) AND PREDOMINANT WIND DIRECTION

MARMUGAO

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Wind speed in km/ hr.	7.1	8.4	9.0	9.4	9.9	13.4	14.9	11.7	7.4	6.0	5.4	5.9	9.0
Direction in the morning.	C/W	W/C/NW	W/NW/C	W/NW/C	W/NW/C/E	W/NW/SE	E/SE/W	W/C	C/W/NW	C/W/NW	C/W	C/W	
Direction in the evening.	NW/C/N	NW/N	NW/N	NW/N	NW/C/N	NW/E/N	E/NW/C	C/E/NW	NW/C/N	C/NW	C/NW	C/NW	

TABLE- 6

SPECIAL WEATHER PHENOMENA

MARMUGAO

NO OF DAYS WITH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Thunder	0.0	0.0	0.1	0.1	1.5	3.6	0.7	0.1	1.9	4.7	1.1	0.1	13.9
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dust storm	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Fog	2.4	2.4	1.9	0.3	0.0	0.0	0.0	0.0	0.5	2.1	0.9	0.5	11.0

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