CHAPTER II

PHYSICAL DETERMINANTS OF CASHEW CULTIVATION

2.1 Introduction

Agriculture refers broadly to the technology of raising plants and animals. Fruit farming activity indicates the cultivating of fruit plants and trees. This nature of fruit farming leads to various geographical centers of origin of fruit plants and trees. South Asia, especially India, is considered the center of mango, orange, lemon, whereas Indo Malayan sub centers include banana, coconut and sugarcane. Central Asia is the most important centre of origin of carrot, radish appricot, pear, while Mediterranean region is known as the centre of origin of olive. Thus, the geographical centers of origin of different fruit crops have spread all over the world, showing adjustment with the environmental factors (Tawade, 1980).

Cashew is grown all over the tropics and also part of warm sub-tropics; but mostly between the Tropic of Cancer and Tropic of Capricorn. It includes Latin America (Brazil, Colombia, Cuba, Costa Rica, Dominican Republic, Guatemala, Panama, Peru, El Salvador, Venezuela); Africa (Augola Benin, Cameroun, Cape Verde Islands Guinea, Bissau, Ivory coast, Kenya, Madagascar, Mozambique, Nigeria, South Africa, Tanzania, Uganda, Zaire, Zambia and in other African countries in small populations): Asia (India, Indonesia, Malaysia, Philippines, Sri Lanka) and also in Australia in a limited area (Mandal, 2000).

Physical determinants influence the growth and development of horticultural crops. Cashew is a traditional crop of the Konkan region. The soil and climate of this region are most suitable for growing cashew. The merit of the cashew plant is that, it grows well under
rainfed condition on hill slopes and light soil (Wadkar et al. 2007). The physical factors such as slope, soil, climate and hydrological conditions have great effects on the cultivation of fruit crops and preference of a particular agricultural system.

2.2 Location

The South Konkan is referred to generally, as one geographic entity, it can be subdivided into three divisions- North, Central and South-on the basis of environmental and economic factors (Tawade, 1980).

The coast from the Shastri river to the Terekhol creek (from Jaigad to Redi) marking the Goa frontier may be considered to constitute South Konkan (Arunachalam, 1967).

The coastal region of Konkan south of Savitri river is called South Konkan. It differs from the middle Konkan by a thick and extensive cover of laterite, deeply entrained drainage, a greater degree of inaccessibility and isolation (Diddee, et al., 2002).

The South Konkan region of Maharashtra covers an area of about 13295.5 sq km. It lies in the southern part of Konkan in Maharashtra, between 15° 36’ North to 18° 50’ North latitude and 74° 36 East’ to 75° 50’ East longitude. The total population of study region is 25,58154 (2001).

The study region stretches over south western part of Maharashtra. The region is bounded by Arabian Sea to the west, northern part of Goa and Karnataka to the South, Raigad district to the north and Satara, Sangali and Kolhapur districts of Maharashtra and some part of Belgaon district of Karnataka to the east (Fig. 2.1). Agriculturally, it is an under developed region. The region comprises 17 tahsils of Ratnagiri and Sindhudurg districts (Fig. 2.2).
Table 2.1
South Konkan of Maharashtra: Administrative Units

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>District</th>
<th>Tahsils</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Ratnagiri</td>
<td>1. Mandangad</td>
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<td></td>
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<td>5. Chiplun</td>
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<td></td>
<td>7. Sangameshwar</td>
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<td>9. Rajapur</td>
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<td></td>
<td></td>
<td>14. Kudal</td>
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<td></td>
<td></td>
<td>16. Sawantwadi</td>
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</tbody>
</table>


2.3 Geology

Geologically Ratnagiri (including Sindhudurg) district is covered extensively by Deccan Basalt lavas of Upper Cretaceous to Palaeogene age. The intrusive phase has very limited extent. The Sindhudurg district exposes rocks ranging in age from Archaean to Quaternary period (Geological Survey of India, 2001).

In the South Konkan, Archaean basement complex consisting of unclassified crystalline gneisses and schist’s occurs at Kankavali, Malwan, Sawantwadi, Dodamarg and Vengurla tahsils. Foote records the occurrence of ferruginous sandstones, quartzites and talcose rocks at times interstratified with green hornblendic and mica schists of Dharwar age in the Kankavali, Sawantwadi and Dodamarg tahsils. Significant inliers of the Kaladgi series appears exposed at the foot of the Phondaghat in Sindhudurg district, due to the removal, locally, of the upper basaltic cover. Other such small outlying patches occur near the seacoast at Achra near the mouth of the Achra Creek near Malwan and around Ramghat. The extensive development of laterite in the
study region and over the higher elevations of the Ghats is a significant fact of the tertiary geology (Arunachalam, op. cit., p. 148).

The coastal laterites are best preserved in South Konkan and occur as plateaux between rivers. The indurated laterites sometimes unconformably rest on the weathered besalts or lignite beds known as ‘Ratnagiri beds’ (Sahasrabudhe and Rajaguru, 1990).

The alluvial deposits, of small extent and little geological interest, form the small flats along the lower courses of the larger streams (Gazetteer of the Bombay Presidency, 1996).

2.4 Relief

Relief affects agricultural operations in many ways. It can be said that there exits a close relationship between relief and agriculture. If the region is generally hilly or rugged, the area under cultivation would be very small and scattered. Owing to uneven relief the layer of the soil would be very thin and flimsy. As a result, mechanical implements cannot be used and agricultural produce cannot be transported easily because the transport is restricted in hilly regions. Altitude affects climate and climate in turn determines the type of crops that can be cultivated in a certain region. In places that have a stony relief, there is dispersal of population and that hinders agricultural operations (Shafi, 2006).

Physiography is one of the dominant parameters of physical environment and its impact on patterns and density of agriculture is immense (Chouhan, 1987). The topography of the South Konkan is highly uneven with hills and very narrow riverine plains.

2.4.1 Relief Divisions

The Ratnagiri and Sindhudurg districts are coastal districts. Longitudinally, the region can be divided into the piedmont plains at the foot of the Sahyadri, the lateritic plateau and the narrow coastal
plain, a few hundred meters wide, abutted by the lateritic plateau (Dikshit, 2002). The continental divide is seen near the border of the study region. All the rivers in the region originate from the Sahyadri ranges and flow from east to west and ultimately meet the Arabian Sea. The important rivers are Savitri, Vashisthi, Shastri, Kajri, Murkundi, Sukh, Karli, Vaghothan, Devgad, Terekhol, Achra and Mochemad.

The South Konkan is broadly divided into three divisions such as the uplands, midlands and low lands.

A) Uplands

Uplands are the western part of Sahyadri ranges. The crest line of the Sahyadri hills demarcates the eastern boundary of the region. The height of the uplands ranges from 150 mt to 1350 mt high from the mean sea level in South Konkan, the maximum elevation of 1239 mt is observed near Maksandgarh in Sahyadri ranges of Ratnagiri district. The maximum elevation seen in the Sindhudurg district is at Phondaghat hill at above 806 mt. The area close to the ghats is highly dissected with deep valleys. These ranges can not distinguish easily from the midlands. The tops of the Sahyadri hills are often crowned by large massive basaltic rocks provide springs and are the source of the rivers of the Konkan. Upland includes eastern part of Mandangad, Khed, Chiplun, Sangmeshwar, lanja, Rajapur, Vaibhawadi, Kankawali, Kudal, Sawantwadi and Dodamarg tahsils.

B) Midlands

The central part of the study region has many flat topped hills rising to heights of above 300 mts. The midland lies in between 75 mt to 150 mt high from mean sea level consisting of the western part of Khed, Chiplun, Sangameshwar, Lanja, Rajapur, Kanakavali, Kudal, Sawantvadi tahsils and eastern part of Dapoli, Ratnagiri, Devgad and Malvan tahsils. This region is also called as inland tracks.
These plateaux show a gradual slope towards west. This region is having a series of laterite table lands with a varying depth of soil and the rock cropping out at frequent interval. Between the table lands valleys, monadnocks, the large containing strips of rice land. Near the villages fringed with plantation garden of mango, cashew and jackfruits. There table lands are fairly wooded. However, near the coast in Mandangad, Guhagar, Ratnagiri, Rajapur, Devgad and Malvan tahsils are barren plains covered with stones. However, at the head of creeks like Kalawal, Devgad and Rajapur creek are observed and a few watered tracks mostly in the southern part of region. Midland include eastern part of Dapoli, Guhagar, Ratnagiri, Chiplun, Sangameshwar, Kankawali, Sawantwadi and middle part of Rajapur tahsil.

C) Low Lands

The study region has a long coastal plain abutting to the east against a north-south trending escarpment forming a continental divide. The low land area is undulating having elevation less than 75 mt from mean sea level. This belt of low land is very narrow and plain and not continuous, so there is a remarkable border of midland and hills in the low land which is uniformly rocky in some part mostly in Ratnagiri, Devgad, and Vengurla tahsils. In some places, there is red laterite soil with black rocks. On this, coast almost on every fifteen km river meets to the sea. River mouths have a capacity of safe harbour because river creeks are wide, plain which develops lagoons. Coastal zone includes western part of Mandangad, Dapoli, Guhagar, Ratnagiri, Rajapur, Devagad, Malvan and Vengurla tahsils.

The cultivation of cashew is restricted to the altitudes below 700 mt where the temperature does not fall below 20° C for prolonged periods, although it may be found growing at elevation up to 1200 m. It is best adapted to the coastal region (Deshpande, 1971). In the study
region the zone low land followed by midland is suitable for cashew
cultivation.

2.5 Drainage

The study region is dissected by numerous short streams. Rising
in the steep western scarp of the ghats at heights of about a thousand
meters or more, they fall through steep gradients to empty their
currents through swift currents into the Arabian Sea. These rivers
have estuarine mouths, the mouths are often blocked by sand bars spits
growing across them. These rivers overflow during the monsoon season.
Their lower reaches are marshy and tidal (Arunachalam, op. cit., pp.
31-32).

Each stream and river has small drainage area, of small size and
volume. Due to the heavy vertical erosion in the sub-Sahyadrian tract
and are fasts growing which more intensely seasonal in their regime
and equally heavy deposition in the river mouths take place. The flow
is at its maximum in the month of August, soon after the full impact of
the monsoon, and at its minimum in the dry months of March, April
and May. This periodicity produces heavy floods during the rainy
season accompanied by a large scale erosion of the parched and loose
soil surface. The floods widen the valleys and in many places build
alluvial terraces (Deshpande, op.cit., pp. 24-25).

The Kelshi, Kalabadevi, Palfhet, Borya, Yalgat, Kalaval, Achara,
Mochemand Jaitapur, Vijaydurg, Karli and Devgad creeks are
navigable for small water vehicles and useful for fishery.

Savitri, Vashishti, Amba, Jagbudi, Shastri, Ratnagiri, Jaitapur,
Muchkundi, Vaghotan, Devgad, Karli, Tillari, Terekhol, Jog are the
main rivers of this region (Sharma, et.al. 2003). The important rivers of
the region are as follows-
The Savitri (Fig 2.4) flows at the northern boundary of the South Konkan. It originates from old Mahabaleshwar and passes by Mahad and Dasgaon through Southern Raigad and reaches the Ratnagiri district at Mahapral and after a total course of about 80 km falls in to the sea at Bankot.

The Vashishti river rises in the Tivra pass, about 25 km from its source, after a rapid fall through rocky ravines, the river reaches Chiplun, and at this point becomes tidal. Passing the island of Govalkot it suddenly widens, and after a course of 40 kms through low mud banks fringed with mangroves, it reaches at the port of Anjanvel.

The Shastri river rises in the Sahyadri range near Prachitgad. After a total course of about 65 km it falls into the ocean at Jaigad. Flowing for about 26 km west, past the town of Sangameshwar, until it meets the Bav river at Phangas, the course for a few kilometers. Changes abruptly to the north, and then takes a north-westerly direction to the coast. During its course several small rivers unite with the Shastri.

The Ratangiri river rising in the Amba pass, it falls into the sea after a course of some 65 km and which stands at the fort of Ratangiri.

About 19 km south of Ratangiri is another small river the Muchkundi, which rises at Machal near Prabhavli, and flows into the sea with the fort of Purangad on its northern bank.

The Devgad river rises in the Sivgad pass and reaches the sea at the fort of Devgad.

The river Achra a small river, rises in a spur of the Sahyadri range near the Phonda pass, and has a southwesterly course of rather less than 48 km to the sea.

The Karli or Sarambal, rising at the village of Shivapur on the Sahyadri hills to the north of Manohar fort, after a south-westerly course of about 56 km falls into the sea at Malvan.
The Terekhol, also known the Banda river, rises in the Sahyadris to the south of Manohar fort, and flows south west and meets at sea (Gazetter of the Bombay Presidency, op.cit., p.388-390). In the dry season these rivers are fordable.

### 2.6 Soils

In any agricultural operation soil is of the utmost importance as it is the cradle for all crops and plants. The top soil having an average depth of about 15 to 20 cm on the face of the land is the natural body of soil on which plants grow and the farming activities flourish. The standard of living of the people depending on agriculture is often determined by the fertility and productivity of soils (Husain, 2007).

Long-term climatic conditions influence the chemical, physical and biological changes that determine the soil profile. The soil forming process is itself a long-term one. Climate during the period directly affects soil formation through weathering processes and indirectly through vegetation. Soil zones and soil profiles are the matters of careful consideration in the fruit farming activity. In the cultivation of field crops, the period taken is relatively small and hence it leaves greater scope for soil change and recoupment of nutrients. Fruit gardens engage the soil for longer duration. This requires greater care in the selection of fruit farming site (Tawade, op.cit., p.6).

The soils of the region are generally (Fig 2.5) classified into three groups i.e.

1) Laterite soils
2) Coastal alluvium soils
3) Salty soils

#### I) Laterite Soils

The predominant soil in the region is laterite and extensive spreads of laterites are noticed throughout the region. They vary in
colour from bright red to brownish red, owing to the preponderance of hydrated iron oxides. They are acidic and fairly well supplied with nitrogen (0.6 to 2.32 per cent) and organic matter, their texture is loamy. They are porous, non retentive of moisture and are found all over the region except in Mandangad tahsil. The P\textsuperscript{H} value of laterite soil is 4.75 to 6.00 and average value is 5.6, Phosphate (4.30 to 14.4) and Potash are high. The depth of these soils varies from 1 mt to 1.5 mt.

These soils are found in several grades, the main being paddy soil and varkas soil. Both of these soils are available on the slopes of the hills. These are yellowish red in colour and poor in fertility. Paddy, the principal crop of the region grows in these soils and more than 34 per cent of the area is under this crop. The barren land is traditionally cultivated for ragi, vari, nagli, etc, but this practice is being abandoned and there is a definite shift towards horticultural crops like cashew, mango, etc. in the recent years.

The region is famous for its mango crop specially the world renowned Alphonso. There has been rapid increase in the area under cashew-nuts and mangoes with more and more varkas soil being brought under plantations. Entire land-scape is also dotted with coconut, kokum, arecanut and jackfruit trees which thrive well in these soils and climate.

II) Coastal Alluvium soils

The coastal strips have deep sandy loams due to the soil erosion in upper reaches. In these soils coconut and arecanut gardens thrive well (Census, 1991).

In the salty and coastal alluvium soil ratio of sodium chloride is 0.64 to 1.63 per cent; P\textsuperscript{H} value is 5.6 to 8.2, nitrogen 0.41 to 1.18 per cent and Phosphate 24.4 kg per hectare. The depth of these soils is more than 1.5 mt.
III) **Salty soils**  
Due to the inundation of the sea, a part of the coastal soils has become salty. These are locally known as khar land or khajan or kharvat. In Mandangad, Dapoli, Guhagar, Ratnagiri, Rajapur, Devgad, Malwan and Vengurla tahsils, the entire western strips are salty while in other tahsils only patches are noticed.

2.7 **Vegetation**  
In the South Konkan 44400 hectares land is covered by forest which is about 3.36 per cent of the total area (2001). Khed, Sawantwadi, Kankawali and Dodamarg tahsils have relatively larger forest area. The Ghat area is still forested and it lessens towards coast. The main species of trees are:

- Meusa ferrea (Linn.) (*Nagchampa*)
- Dysoxylum Malabaricum (Bodd.) (*White cedar*)
- Calophyllum inophyllum (Linn) (*Poon*)
- Artocarpus (spp.) (*Jack fruit*)
- Hopea wightiana (wall) (*Kavsi*)
- Syzigium cumini (skeel.) (*Jambul*)
- Artocarpus hirsute (Lam.) (*Ran-phanas*)
- Salamaila malabaraica (Scholt and Endl.) (*Silk cotton tree*)
- Lagerstroemia lanceolata (wall.) (*Nana*)
- Antoocephalus cadamba (miq.) (*Kadamb*)
- Dalbergia latifolia (Rox b.) (*Sissum*)
- Terminalia tomeutosa (wand A.) (*Ain*)
- Adina cordifolia (Hook f.) (*Hedi*)
- Pterocarpus marsupium (rox b.) (*Bibla*)
- Holoptelea integrifolia (planch) (*Wavali*)
- Tectona grandis (*Teak*)
- Terminalia paniculata (reth.) (*Kindal*)
Lantana camara (*Ghaneri*)
Carissa carandas (Linn.) (*Karvand*)
Mangifera indica (Linn.) (*Mango*)
Cocos nucifera (*Coconut*)
Areca Catechu (*Arecanut*)
Ananas comosus (merr.) (Pineapple)
Anacardium occidentale (L.) (*Cashewnut*)
Musa paradisiaca (subsp.) (*Banana*)
Gercina indica (*Kokum*)

The other commercially important species are *Apta* leaves, *Palas*, *karviand*, *Bamboo* which are valuable in wicker products (Shinde, 1980).

The tidal forests are observed in all the creeks all along the coastline where mangrove is important species. In the study region number of trees and shrubs like Clove, Nutmeg, Black pepper etc. have medicinal values.

Forest under private ownership have large distribution vice versa forest under government management have a limited and uneven distribution. Forests are an important domestic use source of fuel and raw material in the region. These are bamboos, gum, katha, timber, teak wood, hirda, shikekai, fruits, grass etc.

### 2.8 Climate

Of all the physical factors, climate is quite significant that determines the agricultural land use and agricultural patterns of a region. Climate consists of temperature, rainfall, humidity, sunshine, fog, frost snow, hailstorms, winds and air pressure. All these elements of weather and climate, individually and collectively, determine the agricultural patterns of a region (Husain, op.cit., p. 92).
In the context of fruit farming climate and soil of the region are the chief natural, a suitable combination of which governs the success of fruit growing. All fruits cannot be grown successfully in every type of climate and soil. Therefore, the selection of suitable kinds and varieties of fruits for a particular region should be made on the basis of their performance.

The climate of the study region though moist and relaxing is generally healthy. The rainfall is plentiful and regular. The year may be divided into four seasons, the summer season from March to May, the southwest monsoon season from June to September, the post monsoon season in October and November and the winter season from December to February.

The study of climate includes a various elements or components like temperature, rainfall, humidity, cloudiness, the wind velocity, the duration of sunshine and many other elements of less significance.

2.8.1. Temperature

It plays an important role in determining the success or failure of a fruit crop in a particular locality. Every type of fruit needs a certain range of temperature. The vital temperature for a plant growth and development of different fruits varies from 7°C to 24°C (Bal, 2006).
Table 2.2
South Konkan of Maharashtra: Monthly Maximum and Minimum Temperature of Selected Centers (2000-2001)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Month</th>
<th>Ratnagiri</th>
<th>Harnai</th>
<th>Vengurla</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan.</td>
<td>32.4</td>
<td>19.4</td>
<td>29.6</td>
</tr>
<tr>
<td>2</td>
<td>Feb.</td>
<td>30.2</td>
<td>18.7</td>
<td>27.4</td>
</tr>
<tr>
<td>3</td>
<td>Mar.</td>
<td>31.7</td>
<td>19.7</td>
<td>29.1</td>
</tr>
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<td>4</td>
<td>Apr.</td>
<td>32.0</td>
<td>25.0</td>
<td>30.5</td>
</tr>
<tr>
<td>5</td>
<td>May.</td>
<td>31.8</td>
<td>25.2</td>
<td>31.0</td>
</tr>
<tr>
<td>6</td>
<td>June.</td>
<td>29.8</td>
<td>24.7</td>
<td>30.1</td>
</tr>
<tr>
<td>7</td>
<td>July.</td>
<td>28.3</td>
<td>23.8</td>
<td>28.7</td>
</tr>
<tr>
<td>8</td>
<td>Aug.</td>
<td>28.7</td>
<td>24.0</td>
<td>28.6</td>
</tr>
<tr>
<td>9</td>
<td>Sept.</td>
<td>30.1</td>
<td>24.1</td>
<td>29.8</td>
</tr>
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<td>Oct.</td>
<td>31.3</td>
<td>23.6</td>
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<td>Dec.</td>
<td>34.0</td>
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</tbody>
</table>


In the study region meteorological data are available for three stations i.e. Harnai, Ratnagiri, and Vengurla. Being a coastal region the range of temperature during the entire year is not large. The daily maximum temperature is 30° C to 33° C. The March and May are the hottest month (32.5° C to 35° C). With the onset of the monsoon, temperature drops by 3° C to 4° C. Day temperatures during the monsoon are lower than those in the cold season (24.5° C to 30.5° C). In the post monsoon months of October and November day temperature increases and days in November are as hot as in May. Night temperature is the lowest in January (21.1° C to 31.9° C). Areas within 20 to 25 km of the coast are the most pleasant particularly in the hot
months with the sea breezes blowing, nearly throughout the day. Further in inland during the hot months both days and nights can be oppressive and more so in the tract at the foot of the western Gats. Along the coast the maximum temperature rarely reach 41°C and the range between summer temperature and winter temperature is low and varies from 2.5°C to 9.1°C.

2.8.2 Rainfall

The amount of rainfall and its distribution in a particular region is very important in deciding the type of fruits and varieties which can be grown successfully.
Table 2.3

South Konkan of Maharashtra: Tahsilwise Monthly Rainfall Distribution: 2000
(rainfall in mm)

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<td>804.0</td>
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<td>1137.0</td>
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<td>322.0</td>
<td>--</td>
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<td>531.0</td>
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<td>--</td>
<td>--</td>
<td>3230.0</td>
</tr>
<tr>
<td>8</td>
<td>Lanja</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>154.0</td>
<td>824.0</td>
<td>955.0</td>
<td>767.0</td>
<td>119.0</td>
<td>217.0</td>
<td>16</td>
<td>--</td>
<td>3052.0</td>
</tr>
<tr>
<td>9</td>
<td>Rajapur</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>311.0</td>
<td>893.0</td>
<td>1155.0</td>
<td>676.0</td>
<td>136.0</td>
<td>156.0</td>
<td>--</td>
<td>--</td>
<td>3327.0</td>
</tr>
<tr>
<td>10</td>
<td>Vaibhavawadi</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>651.6</td>
<td>1220.4</td>
<td>860.0</td>
<td>170.0</td>
<td>427.0</td>
<td>--</td>
<td>--</td>
<td>3329.0</td>
</tr>
<tr>
<td>11</td>
<td>Kanakawali</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>650.0</td>
<td>1205.0</td>
<td>791.0</td>
<td>81.0</td>
<td>129.0</td>
<td>--</td>
<td>--</td>
<td>2891.0</td>
</tr>
<tr>
<td>12</td>
<td>Devagad</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>821.0</td>
<td>1274.0</td>
<td>642.0</td>
<td>79.0</td>
<td>148.0</td>
<td>--</td>
<td>--</td>
<td>2964.0</td>
</tr>
<tr>
<td>13</td>
<td>Malwan</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>916.0</td>
<td>1490.0</td>
<td>763.0</td>
<td>80.0</td>
<td>64.0</td>
<td>--</td>
<td>--</td>
<td>3313.0</td>
</tr>
<tr>
<td>14</td>
<td>Kudal</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>777.6</td>
<td>1230.0</td>
<td>682.0</td>
<td>58.0</td>
<td>77.0</td>
<td>--</td>
<td>--</td>
<td>2825.0</td>
</tr>
<tr>
<td>15</td>
<td>Vengurla</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>989.6</td>
<td>1531.4</td>
<td>763.4</td>
<td>82.2</td>
<td>124.4</td>
<td>--</td>
<td>--</td>
<td>3491.0</td>
</tr>
<tr>
<td>16</td>
<td>Sawantwadi</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1381.5</td>
<td>1248.8</td>
<td>1046.7</td>
<td>110.0</td>
<td>105.3</td>
<td>--</td>
<td>--</td>
<td>3892.3</td>
</tr>
<tr>
<td>17</td>
<td>Dodamarg</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

The monsoon bursts over the region generally by the beginning of June and rains continue with little intermission till about the middle of October. The average annual rainfall for the region as a whole is 365 cm. The rainfall increases rapidly from the coast towards the Western Ghats on the eastern border of the region. In and near the Ghats rainfall is very heavy. Amboli gets annually on an average 7446 mm of rain. The coastal stations of Malwan and Devgad get annually 2001 mm and 2524 mm of rain respectively. Practically the entire annual rainfall occurs during the months June to October (91 per cent). The rainiest month is July. The variation from year to year in the rainfall is not large.

On an average there are 115 rainy days in the year. As in the case of the amount of rainfall the numbers of rainy days are lower near the coast than in the eastern portion of the region near the Ghats (I.M.D.1974).

The crop production is concentrated only in kharif season and there is very little cropping in rabi or hot weather season. Since, the rainfall is very high and assured the kharif season crops are assured. The concentration of rainfall during four months coupled with latertic soil has imposed restrictions on availability of irrigation facilities and also drinking water in summer season. There are some post monsoon rains in October and November, which enable growing some rabi pulses and vegetables on residual moisture.

**Intensity of Rainfall**

Intensity of rainfall refers to the rate at which rainfalls in a 24 hour period. It is significance as it influences the intensity of soil erosion by rain and the usefulness of rain for agriculture. The average intensity (I) of rainfall is calculated as:
\[ I = \frac{A}{N} \]

Where,

\[ A = \text{Total rainfall over a given Period.} \]
\[ N = \text{Total number of hours of rain or number of rainy days.} \]

It is also important to understand rain spells and drought of dry-spells as they have an important bearing on the agriculture of an area. They are the result of prevalence of significant rainfall abnormalities (Singh and Dhillon, 1984).

**Table 2.4**

**South Konkan of Maharashtra: Annual Rainfall and Number of Rainy Days (2006)**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Tahsil</th>
<th>Rainfall in mm</th>
<th>No. of Rainy Days</th>
<th>Intensity of Rainfall (mm/rainy day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mandangad</td>
<td>4289</td>
<td>104</td>
<td>41.24</td>
</tr>
<tr>
<td>2</td>
<td>Dapoli</td>
<td>3553</td>
<td>147</td>
<td>24.17</td>
</tr>
<tr>
<td>3</td>
<td>Khed</td>
<td>4037</td>
<td>124</td>
<td>32.55</td>
</tr>
<tr>
<td>4</td>
<td>Guhagar</td>
<td>2522</td>
<td>94</td>
<td>26.82</td>
</tr>
<tr>
<td>5</td>
<td>Chiplun</td>
<td>4594</td>
<td>129</td>
<td>35.61</td>
</tr>
<tr>
<td>6</td>
<td>Sangameshwar</td>
<td>6677</td>
<td>119</td>
<td>56.10</td>
</tr>
<tr>
<td>7</td>
<td>Ratnagiri</td>
<td>3292</td>
<td>110</td>
<td>29.92</td>
</tr>
<tr>
<td>8</td>
<td>Lanja</td>
<td>3587</td>
<td>123</td>
<td>29.16</td>
</tr>
<tr>
<td>9</td>
<td>Rajapur</td>
<td>5256</td>
<td>122</td>
<td>43.08</td>
</tr>
<tr>
<td>10</td>
<td>Vaibhavawadi</td>
<td>4272</td>
<td>117</td>
<td>36.51</td>
</tr>
<tr>
<td>11</td>
<td>Kanakawali</td>
<td>3246</td>
<td>125</td>
<td>25.96</td>
</tr>
<tr>
<td>12</td>
<td>Devgad</td>
<td>2524</td>
<td>96</td>
<td>26.29</td>
</tr>
<tr>
<td>13</td>
<td>Malwan</td>
<td>2001</td>
<td>94</td>
<td>21.28</td>
</tr>
<tr>
<td>14</td>
<td>Kudal</td>
<td>2218</td>
<td>120</td>
<td>18.43</td>
</tr>
<tr>
<td>15</td>
<td>Vengurla</td>
<td>2425</td>
<td>98</td>
<td>24.74</td>
</tr>
<tr>
<td>16</td>
<td>Sawantwadi</td>
<td>4539</td>
<td>115</td>
<td>39.46</td>
</tr>
<tr>
<td>17</td>
<td>Dodamarg</td>
<td>3517</td>
<td>111</td>
<td>31.68</td>
</tr>
</tbody>
</table>

The intensity of annual rainfall (Table 2.4, Fig 2.8) varies from above 56 mm per rainy day to below 18 mm per rainy day. The high intensity occurs (above 35 mm) in Mandangad, Chiplun, Sangmeshwar, Rajapur, Sawantwadi and Vaibhavawadi tahsils. The moderate intensity (25mm to 35 mm) is observed in Khed, Guhagar, Ratnagiri, Lanja, Kankawali, Devgad and Dodamarg tahsils. The low rainfall intensity (below 25 mm) occupies Dapoli, Malwan, Kudal and Vengurla tahsils. The intensity of rainfall commensurate the rate of annual average rainfall received in the region (Fig 2.8).

2.8.3. Other Weather Phenomenon

The other weather phenomenon includes humidity, cloudiness, winds etc.

A) Humidity

Owing to the proximity of the sea the region is on the whole very humid. Even during the winter and summer months the relative humidity seldom goes below 50 per cent.

B) Cloudiness

Cashew is sun loving tree crop, cloudy weather and heavy rains reduce the yield. During the monsoon season skies are heavily clouded to overcast, but in the rest of the year skies are clear or very lightly clouded. This situation is very suitable to grow cashew tree crop in the region.

C) Winds

High velocity and hot winds affect heavy damage to fruit trees. They cause breakage of limbs of fruit trees. High velocity winds also cause shedding of flowers and dropping of immature fruits. Winds are very strong and are mainly westerly or southwesterly during the monsoon months. In the rest of the year winds blow from directions
between north and east in the morning and between west and north-west, in the afternoons.

**D) Special Weather Phenomenon**

During the pre and post monsoon months the region experiences very strong winds, sometimes reaching gale force particularly very near the coast and heavy rain in association with cyclonic storms which develop in the Arabian Sea and move in close proximity to the coast. Some time cyclonic storms affected the Cashewnut. The fayan cyclone occurred in the year 2009 has affected adversely on cashew crops (Nalawade and Pawar, 2011). Thunderstorms are common in May and June and again in September and October (I.M.D., op.cit., pp.31-35).

**2.9 Agro- Climatic Zones**

India in endowed with diverse agro- climatic conditions capable of producing almost all types of agricultural production. It includes fifteen agro- climatic regions which have been delineated in relation to the physiographic, main climatic elements, soil types and groundwater reserves, illustrate the main crops and their combinations. South Konkan includes ‘west coastal plains and the hills’. This coastal strip along the Arabian Sea from the south of Mumbai all along through Goa and Kerala but rainier and backed by the Western Ghat esearpment in comparison to its eastern counterpart, mentioned above. This is predominantly an area of rice accompanied with pulse and coconut. There is a diversified plantation economy ranging from cashew nuts and mango orchards at the foothill junctions with lowlands (Pal, 1998).

Out of nine Agro- Climatic Zones (ICAR, 1991) of Maharashtra, two zones are represented in South Konkan i.e. very high rainfall zone with lateritic soil and western ghat zone or ghats’ zone. It is on the basis of soil type, rainfall, and vegetation.
I) Very High Rainfall Zone with Lateritic Soils

This zone comprises major part of the study region (Fig. 2.9). Total area of this zone is 13.20 lakh ha and area under cultivation is 3.5 lakh ha. Its average daily temperature is above 20°C throughout the year. May is hottest month recorded above 33°C. Major rainfall occurs during South west monsoon from June to September. Average annual rainfall recorded is 3105 mm in 101 rainy days. Soil type is laterite, pH Value is 5.5 to 6.5 having acidic nature. The soils are poor in phosphorous rich in nitrogen and potassium (Directorate of Agriculture, Maharashtra State, Pune). Rice is major traditional crop followed by ragi; where as horticultural crops like mango, coconut, cashew and jackfruit are grown in the study region. The spices grown are clove, nutmeg and blackpepper.

II) Western Ghat Zone / Ghat Zone

It includes hilly high lying terrains of least amount of area in eastern part of study region towards south to north. Its altitude varies from 1000 to 1900 mts. Maximum temperature ranges from 29 to 39°C and minimum temperature ranges from 13 to 20°C. Average annual rainfall is 300 to 600 cm. Soils are varkas i.e. light laterite and reddish brown, which are distinctly acidic having poor fertility, low phosphorous and potash content. Principal crops grown are rice and ragi. This zone is well suited for rainfed crops. Mango, cashew, jackfruit, jamu and karvand are the main fruit crops (Diddee et al., op. cit., p.185).

2.10 Water Resources

Successful orcharding needs adequate irrigation facilities. Although under the conditions prevailing in major parts of the subcontinent some mature trees may bear large crops even in the absence of irrigation owing to their deep and spreading root system. The younger trees require ample watering for their economic survival.
Availability of cheap source of irrigation and good drainage control economic bearing of orchards. For trees which thrive under conditions of water logging and in heavy soils it may sometimes be necessary to provide artificial drainage (Singh Amar, 1996).

The origin, distribution and utilization of water resources of any region are profoundly affected by its physical features. Similarly, the need for irrigation and drainage is mainly determined by the geological, topographical and meteorological conditions of a region. The study of landform is important as it delimits the areas easily accessible only for lift irrigation or unfit for irrigation. Such investigations also lead to the possible irrigational and agricultural plans for development in various sectors (Pawar, 1989).

The water resources of South Konkan include surface water through the rivers, streams, lakes and ground water.

2.10.1 Surface Water

The rivers of South Konkan are west flowing, short streams, narrow throughout its course and non-perennial. In study region there are two major irrigation projects, 10 medium irrigation projects and 33 minor irrigation projects. Out of irrigation projects of Maharashtra state 6.25 per cent major, 5.46 per cent medium and 1.38 per cent small irrigation project are observed in study region.

A) Major Irrigation Projects

i) Talamba Project:

It is located at village Talamba in Kudal tahsil. Proposed height and canal length of this dam is 58.35 mts and 87.20 km respectively. After complication of this project the region will be benefited by 17000 hectares area under irrigation.

ii) Tilari Project:

Tilari project is located at village Tilari in Dodamarg tahsil, which is jointly collaborated with Maharashtra and Goa state. Proposed length of canal is 171.22 km. The proposed irrigated area of this project is 23654 hectares. However, only 67 hectares land is under irrigation.
### Medium Irrigation Project

#### Table 2.5
South Konkan of Maharashtra: Medium Irrigation Projects

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Project</th>
<th>Tahsil</th>
<th>Canal length (km) Sanctioted</th>
<th>Complited</th>
<th>Max. Capacity (M. L. Cub. mit)</th>
<th>Actual storage (M. L. Cub. mit)</th>
<th>Total benefit ed Area (ha)</th>
<th>Land suitable for Cultivat ion (ha)</th>
<th>Irrigated Area After Complition (ha)</th>
<th>Actual Irrigated Area (ha)</th>
<th>Seasonal Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Natuwadi Khed</td>
<td>36</td>
<td>36</td>
<td>28.08</td>
<td>8.715</td>
<td>2390</td>
<td>2139</td>
<td>2050</td>
<td>--</td>
<td>198.55</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gadnadi Sangmeshwar</td>
<td>71</td>
<td>15</td>
<td>65.32</td>
<td>Not Stored</td>
<td>3578</td>
<td>2862</td>
<td>2576</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Arjuna Rajupar</td>
<td>129.50</td>
<td>Primary Stage</td>
<td>74.67</td>
<td>--</td>
<td>7037</td>
<td>5967</td>
<td>5704</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Jamada Rajapur</td>
<td>107.50</td>
<td>Not Started</td>
<td>48.05</td>
<td>--</td>
<td>5075</td>
<td>4239</td>
<td>3500</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Nardave (Mahamadwadi)</td>
<td>Kankavali</td>
<td>--</td>
<td>93.374</td>
<td>--</td>
<td>12409</td>
<td>8686</td>
<td>6107</td>
<td>--</td>
<td>40.00</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Aruna Vaibhavwadi</td>
<td>70.30</td>
<td>00</td>
<td>93.37</td>
<td>--</td>
<td>7181</td>
<td>6379</td>
<td>5310</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Devdhar Kankavali</td>
<td>14.00</td>
<td>5.72</td>
<td>100.42</td>
<td>7.464</td>
<td>5937</td>
<td>4750</td>
<td>4512</td>
<td>--</td>
<td>806.00</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Sarambala Sawanrwadi</td>
<td>37.47</td>
<td>00</td>
<td>96.25</td>
<td>--</td>
<td>7464</td>
<td>6755</td>
<td>6190</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Tarandale Kankavali</td>
<td>482</td>
<td>00</td>
<td>10.08</td>
<td>--</td>
<td>798</td>
<td>744</td>
<td>550</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Shrsinghe Sawantwadi</td>
<td>38.20</td>
<td>00</td>
<td>46.92</td>
<td>--</td>
<td>4764</td>
<td>3810</td>
<td>3049</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>591.21</td>
<td>16.17</td>
<td>39548</td>
<td>--</td>
<td>1044.5</td>
<td></td>
</tr>
</tbody>
</table>

The medium irrigation projects in study region are as follows.

The South Konkan having 10 medium irrigation projects (Table 2.5, Fig 2.10) which are Natuwadi, Gadnadi, Arjuna, Jamda, Nardave (Mahamadwadi), Aruna, Devdhar, Sarambala, Trundle, and Shirshinge. All these medium projects are in working phase. Irrigated area under these projects would be 39548 hectares.

In the year 2006-07, 5818 minor irrigation works are completed. Which covers 14000 hect irrigated land in the region.

2.10.2 Ground Water

Groundwater referred to here is found in the saturated lower portion of the rocks beneath the surface of the earth. It is frequently available in various forms such as tube well, springs, etc. depending on the geological setting of the region.

Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form oases as wetlands. The groundwater is also often with drawn for agricultural, municipal and industrial use by constructing and operating extraction wells.
Table 2.6

South Konkan of Maharashtra: Ground Water Resources

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Particulars</th>
<th>Ratnagiri District</th>
<th>Sindhudurg District</th>
<th>Region Total</th>
<th>Maharashtra Total</th>
<th>Region % to State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Annual replenishable ground water resource (Ha m)</td>
<td>48909</td>
<td>27628</td>
<td>76537</td>
<td>3579196</td>
<td>2.13</td>
</tr>
<tr>
<td>2</td>
<td>Natural Discharge during non-monsoon season (Ha m)</td>
<td>2450</td>
<td>1393</td>
<td>3843</td>
<td>187930</td>
<td>2.04</td>
</tr>
<tr>
<td>3</td>
<td>Net annual ground water availability (Ha m)</td>
<td>46459</td>
<td>26235</td>
<td>72694</td>
<td>3391266</td>
<td>2.14</td>
</tr>
<tr>
<td>4</td>
<td>Annual Ground Water draft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Irrigation (Ha m)</td>
<td>4031</td>
<td>5602</td>
<td>9633</td>
<td>1594543</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>Domestic and Industrial uses (Ha m)</td>
<td>1219</td>
<td>1826</td>
<td>3045</td>
<td>105158</td>
<td>2.89</td>
</tr>
<tr>
<td></td>
<td>Total (Ha m)</td>
<td>5249</td>
<td>7428</td>
<td>12677</td>
<td>1699701</td>
<td>0.74</td>
</tr>
<tr>
<td>5</td>
<td>Projected demand for domestic and industrial uses for next 25 years (Ha m)</td>
<td>2438</td>
<td>3651</td>
<td>6089</td>
<td>210270</td>
<td>2.89</td>
</tr>
<tr>
<td>6</td>
<td>Groundwater availability for future irrigation (Ha m)</td>
<td>38772</td>
<td>15156</td>
<td>53928</td>
<td>1539310</td>
<td>3.50</td>
</tr>
</tbody>
</table>


For the present analysis of groundwater resources the data is made available from Ground Water Survey and Development, Govt. of Maharashtra but the said data is not available at tahsil level. Hence the analysis is made at district level for which data is available.

As such the annual replenishable groundwater resource in the study region (Table 2.6) is 76537 Ha m (2.13 per cent of state), where as net annual ground water availability is 72694 Ha m. In the study region ground water availability for future irrigation is 53928 Ha m which will be of much use for agricultural development.
2.11 Conclusion:

The region covers 4.32 per cent of the geographical area of state comprising 17 tahsils from Ratnagiri and Sindhudurg districts. The physiography of the region is divided into three divisions i.e. uplands, midlands and low lands. At least 85 per cent area of the region is having undulating topography.

Geologically the region is covered extensively by Deccan Basalt Lavas. The region is dissected by numerous short streams, rising in the steep western scrap of the Ghats. The rivers have seasonal nature of flows. The rivers are entirely rainfed and the ground water support is inadequate.

The soils of region are grouped into three group i.e. laterite soils, salty soils and coastal alluvium soils. The light, varkas, lateritic soil on the hill slopes between 100 mt to 150 mt contours is suitable for cashew cultivation.

In the study region daily maximum temperature is 30 °C to 33 °C. The range of annual temperature is very low. The rainfall is reliable and heavy from 200 to 400 cm. It increases from coast towards the Western Ghats. Temperature, rainfall and humidity together form the growing season of cashew. The gusty winds and cyclones create many hurdles during the cropping season.

The water resources of region consists surface water and ground water. However, area suffers from water deficit in summer season. The annual replenishable ground water resource is 76537 Ha m which needs to be tapped properly for the agricultural and industrial development of the region.
References

8. Diddee et al., op. cit., p.185.
17. Husain, op. cit., p. 92.

