INTRODUCTION

0.1) INTRODUCTION: - Agriculture is the main stay of India. It still forms the backbone of the Indian economy, despite concerted efforts towards industrialization in the last two decades. Agriculture contributes a high share of net domestic product by sectors in India. Further it is not surprising that in the Indian economy, with agriculture as the dominant activity, the main source of livelihood is agriculture itself. Agriculture also has been the source of raw materials to India’s leading industries. Agriculture is one of the fundamental activities of human-life. It is considered as one of the oldest and most important of all the economic activities of man. Agriculture is related to the raising of domesticated plants and animals as activities to satisfy man’s needs. Nowadays agriculture has become the world’s most important industry.

The credit of introducing this pioneering approach in Agricultural Geography goes to L.D. Stamp (1962) several land-use studies followed studies in India. Chatterjee (1941) And M. Shafi (1951) focused attention on the needs of land utilization survey. The influence of physical factors, especially, morphological factors on land-use, was emphasized by Deshpande, Bhatt and Malvinkurve (1959). The importance of land-use surveys has been explained in detail by Ganguli (1964). The micro-studies to highlight the need of proper utilization of land and the connected agricultural problem have carried out by Karimi (1050) and Lahiri (1950). Mr. Shafi (1960) carried out extensive field work in Uttar Pradesh and came up with actual land-use maps at micro or even Nano-levels. The changing land-use and recent trends have also been studied. M. Shafi (1965) has studied the changing land-use patterns. Noor Mohammed (1971), A.R. Kumbhare (1976), S.D. Shinde (1980). Indrapal and Lakshmi Shulka (1981) have focused their attention on the land-use of specific regions.

Environment and man has been the central theme in Agriculture Geography. Environment plays an important role in agriculture. Environmental factors exert direct and indirect influence on the agriculture land-use and yield of crops. The reason is not just the constantly changing relationship of man, agriculture and environment
overtime and space, but also the fact that a large and increasing proportion of the population. Environment influences the yield directly by affecting the structural characteristics of the crops such as density of plants, number of tillers, vegetative growth, weight of grains per etc. It is known that environmental factors like relief, slopes, accessibility, distance from crest, precipitation, temperature, sunshine etc. have a profound influence on the agriculture and agriculture land-use.

Agro-climatological studies of various kinds are essential for the future development of the areas where the population pressure is great. In recent times various methods have been developed for research in agro-climatological studies. Environment-crop relationship studies have been carried out in U.K., U.S.A. and to some extent in India. The methodology applied in these studies is mostly statistical. A methodological note for studying the influence of weather on crop yields. (Seth, Sardana, and Mallik 1970, 1-6) where in results and techniques used by several research workers have been included. According to these authors, these techniques may be broadly grouped, under three heads.

1. Fisher’s techniques of fitting distribution constants.
2. Fitting of probability distribution to meteorological variables.
3. Correlation and regression studies during different phases of plant growth.

Fishers (1924) developed a novel approach for undertaking crop-weather relationship studies. His approach is based on the consideration that in studying the influences of a weather factor such as rainfall on crop yield. He studied the relationship between rainfall and yield of wheat for a period of 60 years collected from the Rothamstead experimental station U.S.A. . . . The effect of the amount and distribution of sunshine on the yield was studied by Tippet (1926). The partial regression of Barley yield on the distribution constants of rainfall was studied by Wishart and Mackenzie (1930).

Venkatranam in 1930 studied the effect of rainfall on the yield of cotton of Koilpatti (Madras). A series of cotton yields from Akola Farm for a period of 28 years was studied by Kalamkar and Stakopan (1935) in relation to rainfall. Devis and
Pallesen (1940) studied the influence of rainfall and evaporation on yield of spring wheat at Dickinson, North Dakota for the period 1898-1934.

Crop -weather relationship was also studied by Nair and Bose (1945), Gangopadhyya and Sarkar (1965), and I.C.A.R. Scheme (1965).

Correlation and regression methods to study the effect of one or more of environmental factors on yield were used by many research workers. In these studies the independent variables are either the observation of one or more environmental factors taken during a specified growth period of the crop or during the different phases of the crop growth.

Kincer and Mattice (1928, 53-56) used the method of multiple correlation analysis in the study of weather influence on crop yields. Unakar (1929, 145-161) studied correlation between weather and wheat in the Punjab. Again Kincer (1930, 190-196) on the basis of twenty years data (1909-1928) studied cotton production in relation to environmental factors in the states of North Carolina, Alabama, and Texas etc.

Ramakrishna (1934, 43-54) obtained correlation of weather conditions and yield of cotton in the “Northern” and western tracts. Ramamurti and Banerjee (1966), Singh, Sheshagiri, Kapshe (1970) have studied the relationship between environmental factors and crop land-use.

All these relationships between crop yield and environmental factors (Climatic factors) give a clear idea and these studies suggest ways and means of improving the land-use and crop yield for the ultimate good of human welfare.

The significance of Spatial-temporal analysis of agricultural land-use in a predominantly agricultural country like India can never be overstated. In the context of the alarming increase of population and the relatively low rate of economic growth it is increasingly accepted that the proper and efficient utilization of land resources could be the answer to the problems faced by the country. This is particularly significant even from the modern theoretical view that considers land-use patterns as
dynamic and not static. Man’s main purpose for using land is to gain some sort of satisfaction, such as earning an income or providing recreation rather than “bending with nature.” Moreover, farmers viewed as income optimizers behave like “economic men” and therefore their decisions depend ultimately on two factors, production functions and the prices of inputs and outputs. (found-1971)

Lastly, while geographers have been pursuing topics concerning axel patterns of human activity and the relationship of man to his environment, they have failed to analyze systematically the geographical impact and dynamics of one force in the world today, the policies of comply human organizations, most importantly Governments (James Osborn 1974). In a developing country levels through ever changing rules curbs as well as through national/ state plans of development in a positive sense. The resultant agricultural land-use pattern thus is a product of such diversified approaches and conditions these days.

Every agro geographical reality is transformed with three groups of factors, 1) Man in a certain Socio-economic environment, 2) Natural Environment, 3) Degree of Socio-economic progress of a reason. All these factors influence land-use.

In connection with the study areas, the study of agricultural land-use at village level will focus light on the spatial disparities in Nashik District and also point out the causes responsible for the temporal variations. Thus the study of agriculture land-use has become multidimensional Spatial-temporal analysis of agricultural land-use forms integrale part of agricultural development. It has remained as a base for further planning for the welfare of human beings. Keeping in mind these perspectives further study has been attempted.

The region selected for study purpose is Nashik District (Maharashtra). Intraregional diversities in physical and cultural settings of Nashik District and regional imbalance in economic development of the region are the outstanding features of the district. Basically agricultural landscape is widespread throughout the study region.
0.2) ARRANGEMENT OF THE TEXT:-

The entire study is arranged into seven chapters. The study is concerned with the spatial analysis of agricultural land-use in Nashik District of Maharashtra state. Thus the study of agricultural land use patterns and their spatial variation form the core of the work undertaken. It is proposed to consider the spatial variation in the agricultural land-use in Nashik District with a view to evaluate the influence of certain environmental and economic factors on the distribution pattern. The currently evolving and changing agricultural land-use patterns in the District with special reference to changes that have taken place. An attempt is also made to represent the various parameters of land and socio-economic phenomena and the resulting agricultural location. The work has its limitations imposed by the choice of region and other factors. Several aspects are omitted and the author is fully aware of such omissions which result from lack of data and other resources including time to be devoted for such work.

Chapter – I, deals with physical setting. Since the underlying purpose of the study is to evaluate the influence of physical environment on agricultural patterns, the first chapter begins with the introductions to the study area, followed by the description of physiography through a general study of relied, geology, and drainage. Climate and the distribution of weather elements are also considered along with soils and natural vegetation.

Chapter-II, includes the socio-economic and cultural setting. Further, different aspects of population are also studied. The persons engaged in the agricultural activity are studied along with other agricultural elements like land tenure, land holding, farm implements, marketing, transportation and irrigation. The pattern of irrigation is the subject matter which covers such aspects as evolution, circumstances and limitations for irrigation development, characteristics and spatial-temporal perspectives of different modes of irrigation.

Chapter-III, and Chapter-IV, are devoted to the discussion of general land utilization (Forest, Net sown Area, Area Not Available for Cultivation, Cuturable Waste and Fallow Land) and agricultural land utilization i.e. distribution of main crops.
Chapter- V, deals with regionalization of Agriculture i.e. the associations between the agricultural land-use and various environmental factors. In this chapter different elements of physical and cultural environment, their spatial distribution and their impact on agricultural land utilization are assessed.

Chapter- VI, Summary and conclusion

Chapter- VII, Problems, Prospects and suggestions Studies at micro level.

The last chapter attempts to summarize of the work done. It attempts to summarize the finding and highlights the problems, prospects and suggestions.

0.3) CHOICE OF THE REGION:-

The scale problem is fundamental in geographic studies. In agricultural geography data are collected and generalization made most frequently at different levels of observation. A district study would provide as with a frame on which further research can be based. Keeping this view in mind, the Nashik District was chosen as an area of investigation. The choice was influenced by several considerations. Such a study would provide a useful approach to obtain a more complete understanding of the problems of agriculture in the region.

Secondly Nashik District has a significant location in respect to the Sahyadri ranges. It is a good representative of Maharashtra State in many respects viz. geology, physiography, drainage, natural vegetation and soils. Therefore the study of the agricultural land-use of Nashik District will help to certain extent to understand the agricultural geography of the state.

Thirdly, the district has special physical base. i.e. It represents large variations in topography (Mountains, hill-ranges, plains, flat topped interfluves, steep slopes and gentle slopes etc.) and climate (rainfall from above 50mm to below 4000 mm.) Thus it is possible to evaluate the influence of various environmental factors upon the agricultural land-use.

Environmental factors such as relief, slopes, climate, soils, rainfall etc. play an important role on land-use patterns of the district. The amount of rainfall has
decreased day by day from 1951 to 2011. It is necessary to understand the continuing process of the physical parameter of land on the one hand and the human use of it on the other. Thus utilization of land for agricultural use is a function of physical environment such as location, relief, climate and soil as also of human attributes which are supposed to strike a balance between the environment and its use.

All these considerations have led to the choice of Nashik District as the region for this study in order to understand the agricultural land-use of the region in time space perspective.

0.4) METHODOLOGY:-

The spatial aspects of agricultural land-use in Nashik District are studied from geographical point of view. This necessitates the development of a regional frame for the analysis and compilation of village level data. Gibb’s Formula (1966)\(^2\), Arithmetical Increase Method and Incremental Increase Method are used for population projection. Measures of population changes and the spatial patterns of land-use revealed through maps were based upon quantitative analysis. Topographical maps are used for mapping.

The data collected through primary and secondary sources were processed and represented by statistical and cartographic techniques. The various methods and techniques used are explained in the relevant sections in the text. Concentration and yield index is applied to calculate the intensification of agricultural weightage method for multiplication, while diversification index is used for calculating the diversification of crops. For calculating the levels of development indicators of various parameters are used. Association among them to each other has been tested through correlation analysis, and correlation matrix have been formed and represented graphically by angular relationship to increase the precision of findings.

The work of systematic analysis has been accomplished mainly through the use of the cause and effect models of analysis avoiding passive description, as possible. A spatial analysis based on this methodology covering a period of Reference years 1991 and 2011, has thus facilitated the understanding of land-use behaviors of the region. For enhancing the quality of the work further the smallest viable administrative unit of taluka (Tehsil) has been used in the study.
Weaver’s method and Doe’s method of crop combination are used in this study. Jasbir Singh’s Formula has been applied.

SOURCES OF DATA:

It was proposed to assess the impact of environment since the plan period the average for the year 1991 and 2011 have been abstracted in order to avoid the climatic hazards on different variables. The main body of the data used is collected from the primary and secondary sources. Taluka is considered as a unit of observation to understand the special variation in the agricultural land-use.

PRIMARY SOURCES:

Taluka and village level statistics were collected through different sources for which special questionnaires were designed and circulated to village farmers, village offices and Tahasildar offices. The information collected through interviews and discussion with experienced farmers have also been added to test the validity of the results.

SECONDARY SOURCES:

They include published and unpublished reports and abstracts, such as socio-economic reviews and District statistical abstracts, census handbook, Gazetteers, Agricultural bulletins published by the Department of Agriculture, Maharashtra state, Nashik periodicals published by ground water survey and development agency, Government of Maharashtra, and some unpublished documents by irrigation and power departments. These documents provide a rich back ground material in the form of vast amount of information, which is both comprehensive at village, taluka and District as units of reference. Season and crop report published by the Government of Maharashtra formed a major source of data on land-use and cropping patterns at District level. District census handbooks (1981, 1991, and 2011) of Nashik District compiled by the Maharashtra census office, Bombay were the other important sources of data at village level, population, occupational classes and general land utilization.
The gram panchayat office in the village and the offices of Talathi’s provide information regarding the distribution of crops, landholding, irrigation, wells, general land utilization, population distribution and settlements at village level.

However, certain limitations of data have restricted the scope of the study. Taluka is the area unit in this study. Certain data like yield per hectare, consumption of fertilizers and pesticides, size of operational holdings and land tenures system, information relating to the cultivation of crops, crop weather calendar, agricultural practices and farmers input, output budget etc. was collected by the author through interviews with local farmers during his field work in the region.

Data of some aspects of irrigation and transport were collected from the office of the executive engineer and office of the superintendent, engineer departments of irrigation, Nashik, Band C. department, Maharashtra Engineering Research Institute (MERI) Nashik, and R.T.O. of Nashik region.

0.5) OTHER SOURCES:-

3. Topographical maps of the survey of India,
   (1:250,000,1:63360,1:50000,1:10,000 international series and
   1:250000,46H,47E and 1:50000-46H- 6,7 and 46 L -4,12,14,15.)

0.6) FIELD WORK:-

Field work is very important part of this research work. All information regarding the area under crops, irrigation and specially the areas under changing crops and fruits, vegetable is collected from farmers by filling the questionnaires. In the primary stage of the work, in order to collect data relating to village level agricultural land-use. Tehsil headquarter, irrigation projects, rain gauge stations were visited, information was also collected and observations were noted while travelling. Many tehsil places and some sample villages were visited for correct information regarding cropping patterns, changing patterns of crops and the area under different crops. The correct information of replaced crops of the study region is also found out.
REFERENCE:


14) Lahiri R (1950) : Land utilization in some villages near Jasidih (Deoghar)” Calcutta Geographical Review.


18) Ramakrishnan S. : On the correlation of weather Conditions and yields of kumpta cotton, Dharwar District, Sankhya Vol. 3 pp. 59-64.


Chapter No. 1

ENVIRONMENTAL SETTING OF AGRICULTURAL RELEVANCE

Nashik District is one of the important districts of Maharashtra state. Nashik was considered as a gateway to the western coastal belt of Maharashtra and Gujarat as well as to the central Maharashtra for all the invaders descending from the north during the Mughal period. It lies between 19° 35’ and 20° 52’ North latitude and 73° 16’ and 74° 56’ east longitude with an area of 15530 sq.k.ms. On the basis of Physiography, Historical and cultural relation, Political background, as well as geographical regional characteristics, Nashik District terms district unit. It is rhomboidal in shape with the longer diagonal of about 170 k.ms. from south west to north east and an extreme breadth of about 170 k.ms. from North to South. The study area has a steep scarp of the Sahyadris to the west and gentle slope towards the east. The district occupies North-West position in western Maharashtra with Dang and Surat Districts of Gujrat state to the North-west, Dhule district to the North, Jalgaon and Aurangabad districts to the east, Ahmednagar district in the South and Thana district to the South-West. (Fig.-N0.1.1)

The total geographical area of the Nashik District has 15,530 sq. k.ms., which is 5.06 percent of the total area of Maharashtra state and its population was 2991739 in (1991), 49,93,796 in (2001) and 61,07,187 in (2010-11). According to area Nashik rank 5th and as per population it ranks 4th among the 35 districts of Maharashtra state. The Nashik district was formed in the year 1869 with the city of Nashik as its district headquarter. In other words Nashik is one of the largest districts in the Maharashtra state, both in area and in population.

1.1) HISTORICAL BACKGROUND:-

Nashik has a mythological importance. Due to its mythological, historical, social and cultural importance Nashik has its own personality. The district derives its name from that of its headquarters’ town, for the origin of which the following interpretations are given. The town is sited on the nine peaks or NAVA-SHIKHARA and hence the name is derived. The other relates an incident in the Ramayana, where the place Lakshmana is said to have cut the nose (Nasika) of Shurpanakha. Nashik has a rich historical past as the mythology has it that Lord Rama, the king of Ayodhya made Nashik his adobe during his 14 years in exile. In prehistoric times, like the rest Deccan, Nashik region formed a part of the Dandakaranya, suggesting that the region
was inhabited by the tribes. The region had a well-organized administration in the second century A.D. when it was ruled by the Shalivahanas.
The area passed to the hands of Muslims in the early fourteenth century through a succession of dynasties viz, the Shalivahanas, Vakatakas, Rashtra-kutas, Chalukyas and the Yadavas. Thereafter a new Muslim dynasty called the Bahamani dynasty was established in the Deccan. The Bahamani Empire was integrated at the close of the fifteenth century. The area witnessed the rise of Maratha power in the seventeenth century, which with all its ups and downs continued till the eighteenth century when the Marathas were finally defeated and the region passed into the hands of the British. During the Seventeenth and eighteenth centuries under the British rule Nashik was an important place. Nashik thus continued to hold a significant position in the administrative and cultural life of western Maharashtra throughout the British rule and later even in the post-independence period. The Nashik headquarter as a city is situated on the bank of the Godavari river (Dakshin Ganga) making it one of the holiest places for Hindus all over the world. After every 12 years “Sinhaashtra Kumbh Mela” is successfully organized.

ADMINISTRATIVE HISTORY:

Nashik district is the third largest district in Maharashtra state. The territory now including Nashik District was formerly partly in Khandesh District and partly in Ahmednagar District. Yeola was known as Patoda taluka. In 1837-38 parts of Ahmednagar district consisting of Sinnar, Chandwad and Dindori. Nashik including Igatpuri and Peint taluka were made into sub collectorate under Ahmednagar. The sub collectorate of Nashik was, however, abolished in 1856 and its talukas were incorporated in Ahmednagar district in 1861. Nimar peta under Sinnar and Vanipeta under Dindori were abolished and a new sub-division was formed with headquarters at Niphad. Headquarters of Karnai taluka included in Trimbak peta were transferred to Igatpuri town in the year 1861-62 and the name of the taluka was changed from Karnai to Igatpuri taluka. In 1869 Nashik was made a full-fledged district, with Eight sub-divisions of Ahmednagar (viz. Nashik, Sinnar, Igatpuri, Dindori, Chandwad, Niphad, Yeola and Akole) and three sub-divisions of Khandesh district (viz. Nandgaon, Malegaon, Baglan) together with Peint taluka. Shortly afterwards Akole taluka was returned to Ahmednagar. In 1875 Baglan was divided into two talukas Baglan (Satana) and Kalwan. After some period for some reasons Peint state became British territory and was made a sub-division in 1878.
There were no major changes in the district or taluka boundaries between 1901 and 1948 consequent upon the merger of the Indian states a new Mahal known as Surgana Mahal consisting of the former princely state of Surgana, was created in 1949. In 1950, 11 enclave villages which formed a part of Nandgaon taluka were transferred to Aurangabad district. Two villages (Salher and Vaghamba) from Surat district were added to this district. Four Villages were transferred to west Khandesh or present Dhule district.

1.2) **ADMINISTRATIVE UNITS:-**

For administrative purposes the district has been divided into thirteen talukas (1991). Recently two talukas were created in the district making the total talukas fifteen (2011). According to the 2011 census, there are 23 towns (including Nashik city) and 1960 villages in the district. Out of the total of 61, 07,187 persons in the district about 35, 09,814 live in the rural areas and 25, 97,373 in the urban areas.

**Table No.1.1**  Nashik District- Administrative Units

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Name of Talukas 1991</th>
<th>Name of Talukas 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nashik</td>
<td>Nashik</td>
</tr>
<tr>
<td>2</td>
<td>Peint</td>
<td>Peint</td>
</tr>
<tr>
<td>3</td>
<td>Dindori</td>
<td>Dindori</td>
</tr>
<tr>
<td>4</td>
<td>Surgana</td>
<td>Surgana</td>
</tr>
<tr>
<td>5</td>
<td>Kalwan</td>
<td>Kalwan</td>
</tr>
<tr>
<td>6</td>
<td>Baglan</td>
<td>Baglan</td>
</tr>
<tr>
<td>7</td>
<td>Malegaon</td>
<td>Malegaon</td>
</tr>
<tr>
<td>8</td>
<td>Chandwad</td>
<td>Chandwad</td>
</tr>
<tr>
<td>9</td>
<td>Nandgaon</td>
<td>Nandgaon</td>
</tr>
<tr>
<td>10</td>
<td>Yeola</td>
<td>Yeola</td>
</tr>
<tr>
<td>11</td>
<td>Niphad</td>
<td>Niphad</td>
</tr>
<tr>
<td>12</td>
<td>Sinnar</td>
<td>Sinnar</td>
</tr>
<tr>
<td>13</td>
<td>Igatpuri</td>
<td>Igatpuri</td>
</tr>
<tr>
<td>14</td>
<td>----</td>
<td>Trimbak</td>
</tr>
<tr>
<td>15</td>
<td>----</td>
<td>Deola</td>
</tr>
</tbody>
</table>


   ii) Socio-Economic Review and District Statistical Abstract of Nashik District.
FIG. NO. 1.2: ADMINISTRATIVE UNITS - NASHIK DISTRICT

1990-91

1990-91

2010-11

2010-11
1.3) GEOLOGY:-

The area under study forms a part of Deccan Trap region of peninsular India. The Deccan Trap covers an area of half a million sq. k.ms. in the western and central parts of Indian peninsula. The study area is located mainly in the western part of the state that is commonly known as the Trap region or the Trap country. The great trap region of the Deccan covers the whole district. The district falls in the seismic zone.

It is entirely of volcanic formation. The volcanic portion consists of compact, stratified basalts, and an earthy trap. The basalts are the most conspicuous geological feature to the west. They lie in flat topped ranges, separated by valleys, trending from west to east. In some flows the basalt is columnar and then it weathers into fantastic shapes. The formation of the base of the trap is chiefly amygdaloidal, containing quartz in vertical veins, crystals and zeolites minerals, especially apophyllite weathering into a gray soil. The absence of laterite, which caps the summits of the hills to the south is a curious in the geology of the study area.

The thickness of the basalts varies greatly in the Trap region, the maximum thickness of 2120 m. to 3030 m. is found in the western part of the study area. G.P.I. Walkar has estimated that the thickness of the trap is 2424 m. near Trimbak (Nashik).

The Deccan trap was formed due to consolidation of lava flows that were extruded on the surface through gigantic fissure eruption during the late Cretaceous and early Eocene periods. Most of this tectonic activity took place in the early Eocene period about 60 to 65 million years ago. The flows, however, were erratic and occurred at different times. This has resulted in the complex nature of the Deccan basalt, which shows a remarkable variation in its lithological character. Basically the basalt formations are derived from the sub-aerial flows of the lava.

The western part of the area is dominated by the Sahyadri ranges marked by the preservation relics of the original plateau and the ancient surface of erosion. The Sahyadri ranges have igneous rock structure in the crust, with red soil top surface. The eastern plains of the district have basalt base.
The Sahyadri ranges themselves form the water divide separating the east flowing rivers of the study area and the west flowing rivers in nearby Konkan region.

The recent alluvial deposited by the river action is observed in all major river basins and flood plains of the numerous tributaries.

1.4) PHYSIOGRAPHY:-

Nashik district is situated astride the eastern flank of Sahyadri ranges. The district boasts of some of highest peaks of the ranges like Kalsubai, Salher and Saptashrungi. Satmala is sub ranges. The relief of the presents some interesting features. The western margin of the district is the Crestline of the Sahyadris which divides the Konkan (Coastal lowland) from the upland of Maharashtra and acts as a main watershed of the peninsular rivers separating the west flowing and east flowing rivers. This narrow crest zone has a width varying between 10 and 20 k.ms. and is
called the “Ghats” section. The Crestline is marked by many saddles occurring, generally at the altitudes of 625 to 850 meters from M.S.L. The general land slope is in east-southeast direction and is indicated by Godavari basin slope.

Consequently the “trap” country, as a whole, shows a general eastwards slope and the Crestline of Sahyadri a steep western slope. The Crestline itself is believed that has moved considerably due to headward erosion.

Headward erosion by the major rivers and their tributaries, river captures, emergence of Ghats (i.e. saddles) in the north-south alignment of the Sahyadris and variations in the altitudes of the Crestline itself are some of the important characteristics associated with the western portion of the peninsular plateau of India, of which the study area forms the region to east of the Sahyadris.
Eastward of the Ghats, the study region is dominated by the peaks of Sahyadris rise above 1000 m. occasionally and by river valleys divided by flat topped interfluves. A number of such mesas overlook the valleys, but are separated from them by steep slope or scarps. Dembris has accumulated on lower slopes of the mesas leading to the terraces. The major interfluves and spurs from water divides between the major rivers and their tributaries. To the east lie the broad valleys interspersed with tongue-like spurs that originate from the Sahyadris and generally extend in north west-south east direction. (Fig. No.1.3)

PHYSIOGRAPHIC REGIONS:

The physical environment of the study area is well diversified. The study region is dominated on the west by the Sahyadris. The main system of hill is the Sahyadri and its offshoots. The main Sahyadrian range runs from north to south on the western portion of the district. From the main Sahyadrian range three prominent spurs stretch cut to the east. The central part shows a combination of small and big hill ranges, mesas and buttes and inselbergs, and present generally highly dissected landscape. The central part is also marked by upper courses of the major rivers such as Godavari and Girana. The eastern part shows a comparatively level landscape.
The western part generally has an altitude of more than 900 meters, the central part from 600 to 900 meters, and the eastern part less than 600 meters. It is therefore, customary to divide the study area into three regions based on altitudinal levels. Broadly these altitudinal zones correspond to the western, central and eastern parts of the study area. Such a division is of course based upon the predominance of particular altitudinal class in each section. It is therefore to be noted that altitude variations are observed in each of these Eocene on account of the diversity of relief in terms of the distribution of valleys and divides (Fig. No.1.3)

REGIONS:

The district may broadly be divided into three major regions.

1) Western hilly area (Down Ghats).

2) Transitional zone.

3) Rolling upland. (Godavari and Girana basins).

1) WESTERN HILLY AREA:-

Western mountainous zone is characterized by rugged terrain and heavy rainfall. This region is essentially the Crestline of the scarp face and could be generally identified with the Sahyadri Mountain with altitudinal levels exceeding meters. The Sahyadri itself forms the extreme western edge of the Deccan plateau. It straddles the entire study region. It forms the water divide between the west flowing rivers of the Konkan lowlands and the east flowing rivers which dominate the study area.

The physiographic region follows a sinuous line probably caused by the unequal reclusion of the scarp. The Crestline locally known as the “Ghat Matha”, has different altitudinal levels, but processing may saddles through which the lines of communications pass.

This much dissected region lying to the west of the Sahyadri edge of the Deccan plateau in the district partakes of the nature of the Kokan tract. It includes the extreme north western portion of Nashik, the whole of Paint, the north western part of Dindori and Surgana except a small area to the east and south of the chirai.
With the exception of the Sahyadris, the general direction of mountain ranges is from west to east or south west to north east and the higher portion being near the west. The highest point of the study area is KALSUBAI PEAK (1646 meters or 5400 feet.) It is situated on the southern boundary of the district.

From north to south in the study area, there are many high peaks (Mesas) such as SALHER (1567 meters), MULHER (1306 meters), SAPTASHRUNGI (1416 meters), KEM (1177 meters) and BHORGAD (1080 meters). At the extreme north of the district is the SELBAI range. The highest peaks are found in this range. MANGI-TUNGI (1331 meters) is the highest peak. At the east of the Mangi-Tungi hill is situated the selbari pass. At further east are situated the HINDALBARI pass and THERMAL FORT. Near the extremity of this range within the district is situated the GALNA FORT (710 meters), which has given its name to this line of hills.

DHOLBARI range is another range of the study area. The name is derived from the village Dholbari situated near the pass. This range contains several high peaks such as, HATIMAL (1315 meters), Kutradongar (1190 meters), Kumbaria (982 meters), Nochalas dongar (hill-1122 meters), Adolia (777 meters) and Dhodbla (550 meters).

The Satmala- Chandwad or Ajanta range is right across the district. It differs from the rest of the mountains in the north by the number and shape of its peaks. These peaks are visible from a greater part of the district and form prominent landmarks. The highest of them are DHODAP (1451 METERS), SAPTASHRUNGI (1416 meters), INDRAI (1410 meters) and CHANDVAD (1410 meters). Further to the south-east are the twin forts of Ankai and Tankai (960 meters). The Satmala range branches off from the Sahyadris in an easterly and south-easterly direction.

The Trimbak-Anjaneri range stretches nearly eastwards from Bhaskargad (1080 meters), on the Sahyadris. About 5 km. east of Bhaskargad is Harish fort (1113 meters) and Brahma dongar (1201 meters). However as in other ranges, the greatest heights are attained some distance away from the Sahyadrian scarp at Trimbak (1294 meters) and Anjaneri (1300 meters).

Many big and small ranges emanate from the Sahyadris showing tongue like spurs in the easterly, northeasterly and southeasterly direction. All above and many
other small hill ranges in the study area are interspersed with broad valleys of lower tubes.

Thus the western hilly area (Sahyadri region) presents a complex and varied landscape, characterized by high and low hilly ranges, plateaus and comparatively steep slopes. (Fig. No.1.3).

2) TRANSITIONAL ZONE:-

The second physiographic region, lying to the east of the Sahyadrian scarp. To the east of the mountainous high region is the zone of predominantly 600 to 900 meters altitude. This can be considered as the central or middle region. This is a transitional zone between the higher western region and the lower region. Nearly half of the area of the northern Nashik is formed by this zone.

The physiographic region is marked by Chandwad range or Ajanta range which is the natural divide between the two major river systems, viz. the Girana in the north and Godavari in the south.

Separating the larger river of the district are several other ranges similar to the Dholbari, Anjneri and Sinnar plateau which form the southern and central part of this physiographic region. Anjaneri is a fine mass or trap rock, with lofty upper and lower scarps each resting on a wide and well wooded plateau. Its top is flat and of considerable area. From Anjaneri hill there is a spur extending southwards for about 3 k.ms. from which three branch spurs resembling a Trishul are shown out. The western arm curves in a semicircular form with the crest over 900 meters. The central one is short and straight trading due south. The eastern makes a smaller semicircle whose other end extends eastwards as Ghargad and continues after a couple of gaps into the ridge which contains the Bahulla fort and ends in a series of isolated small hills. The eastern of these is the Shiva dongar just at the west of Deolali cantonment. A little to the north of the hills is a very long narrow low ridge about 50 meters above the surrounding plains which is suggestive of a dyke.

The southern part of the district known as the Sinnar plateau is one of reddish brown soils on rough Sloping ground.
In short this physiographic region is characterized by major and minor hill ranges with varying slopes, Sinnar plateau generally presenting dissected landscape.

3) ROLLING UPLAND:-

The last physiographic region is also known as eastern low region and it is below six hundred meters in altitudinal level. It consists of Godavari and Girna basin. The region is gently sloping plateau occupying a north eastern, central and southern part the study area. In general eastern “low” region is associated with the broad valleys of the two major rivers and some of their tributaries. The Girana in the north and Godavari in the central and southern part have curved broad valley through extensive erosion of the basaltic rock. The black soils formed due to the disintegration of basalt rocks have been responsible for the fertile nature of the land in this region.

The Girana valley presents a small part of the upper basin mainly in the Kalwan and Baglan talukas. It occupies the northern part or the study area. The Godavari basin lies to the south of the Satmalas and east of the Sahyadrian scarp. This region is the most prosperous one. This valley presents a part of the upper basin mainly in the talukas of Nashik and Niphad. It is the zone of high fertility which increases towards the east. Apart from these upper valleys, the region as a whole presents gently sloping landscapes disturbed occasionally by spurs, dotted by knolls and inselbergs.

SLOPE:-

The study area as a whole, shows a general eastward gentle slope and a steep westward slope. The eastward slope in the study area as a whole is gentle i.e. about 3 meters to 1 k. m. But the slope in the western part near the escarpment varies between 50 and 500 meters per kilometer. Thus there are great variations in the general slope in the study area and characteristically, in many micro areas the slope variation is by far greater than the Berge’s, all this shows spatial variations in slopes to a great degree.
1.5) **DRAINAGE:**

The drainage pattern and trend lines of the ridges depend upon the structure of the underlying basaltic rocks of the district. These rocks, interblended with ash layers, have developed three sets of master joints, running approximately in north-south, north-west and north-northeast-southwest directions. The streams of the region have taken advantage of these planes of weakness in curving their valleys as is shown by the following streams generally running one or other of these three sets of directions, the bends at the confluences of almost every rill with its main streams are generally rectangular, and courses of most valleys are almost straight.

**Source:** (B. Arunachalam: - Shifting of the water divide in the Igatpuri-Trimbak Ghats. Bombay Geographical Magazine Vol. XII No. I, p12.)

The district is situated partly in the Tapi basin and partly in the Upper Godavari basin. Nandgaon, Kalwan, Baglan and Malegaon talukas are drained in the north and north-east by Girana River (tributary of Tapi) and its tributaries. The talukas lie in the Tapi basin. Remaining talukas lie in the Godavari basin and are drained by the Godavari River and its tributaries. The Satmala range of hills prove a watershed between the above two basin. Apart from Godavari and Girana, there are a number of small Konkan rivers draining westwards into the Arabian Sea.

The district is drained by two main rivers, the Girana and the Godavari and their tributaries. Godavari rises near Trimbakeshwar and drains Nashik and Niphad talukas, is the most important river and is known as “Southern Ganga”. Apart from these rivers there are a large number of small konkan rivers draining westward into Arabian Sea among which the Vaitarna is the only useful river which has been harnessed for generating electricity in Igatpuri taluka. The other important rivers are Darna, Mosam, Kadava, Unanda and Kashyapi.

**GODAVARI BASIN:**

The proper Godavari River comprises the talukas of Nashik and Niphad. It originates on the high slopes of the Sahyadris at Brahmagiri near Trimbakeshwar, where rainfall is heavy. (19° 56’ N and 75° 31’ E.). It flows south eastwards and is joined by many tributaries such as Darana, Kadawa, Banganga etc. Vaki, Unduhol,
Valdevi, Dev, Jham and Pimpalad are tributaries such Darana and Kadawa. The upper valley of the Godavari only is included in the study area. With the slope it flows to southeast as the other rivers do.

In the source region Godavari river first flows north-east. Debouching form Brahmagiri, the river Godavari collects main tributaries like Kadawa, Banganga from the north and Darana, Nasardi, from south, which is the other most important tributary. Apart from these important tributaries, the Godavari is fed by many second and third order streams and the drainage pattern is of the dendritic type. All the rivers and tributaries of the Godavari’s system have considerably eroded the western and central portion of the Nashik district. In the eastern part of the study area, the Godavari has formed a broad valley with considerable alluvial deposits on the bank.

**KASHYAPI:** The Kashypi (Kas) river rising a little above Wagira in the Sahyadris and augmented by the waters of the Wotki and the Muli, is the next stream to join the Godavari. Just at this confluence is constructed the Gangapur dam, whose storage backs up both the main river and its tributary, the Kashyapi. 5 km. further to east, at Jalalpur, the Godavari is met by the Alandi, a small stream flowing from the north, a few hundred meters below the meeting point.

About 3 km. below Nashik, the Godavari receives the Nasardi on the right, a small but important stream rising 16 km. west of the town in the Anjaneri range. From this stream the chief water supply of Nashik is drawn, being conducted by a channel to a sort of basin in the town. Below this the main stream widens, but rocks still obstruct its course. The banks continue high, but become earthier as the river flows east.

**DARNA:** The Darna rises on the northern slopes of the Kulang hill fort in the Sahyadris about 13 km. south-east of Igatpuri. Though the straight line distance from the source to its influence with the Darna is only about 50 km.; it has a very long and winding course as much as half of that distance. Its banks are like those of the Godavari below Nashik, of no great height, but broken by scores of small streams, making the passage along the banks of the river very difficult for laden carts.
On the right bank, at Belu, the river Darna receives the Kadva, not a large river, but a small stream flowing north-eastwards between Mhordan-Katlia hills on the west and Kalsubai-Bitangad Patta range on the east in the south-eastern part of Igatpuri taluka. On the left bank the Darna has only three tributaries of any size, and they hold little water during the hot season. They are the Waki, the Undukol and the Valdevi.

**FIG.NO. 1.4: NATURAL DRAINAGE PATTERN**

**BANGANGA:** Among the north bank tributaries, the Banganga rises a little to the north-west of Ramsej hill and flows in a general easterly course passing by Ozar, where a dam crosses it to divert the water into canals on both sides for irrigation. After passing Sukene it joins the Godavari.

**KADVA:** The Kadva rises in the Sahyadris to the north-west of Dindori in the angle between the former and the Satmala range, and crosses Dindori from north-west to south-east. It is rocky both in bed and bank, but the bed is wide, and the average
volume of water is small compared with the area through which it flows. Irrigation works of considerable importance have been constructed on it.

1) **GIRANA BASIN:**

THE Girana is the second important river of the study area. It rises at the west of the district in Surgana taluka, just south of Cheri village at about 8 k.m.s. south west of Hatgad in the Sahyadris and flows nearly east along wide bed, with high banks in Kalwan, Baglan and Malegaon talukas. It winds its way northwards as it nears the Jalgaon frontier. In the upper course, Girana receives several rivers of nearly equal size as itself. Girana collects main tributaries like Tamboli, Punand, Aram and Mosam from north and Panjan from south. Mosam is the northernmost tributary of the Godavari and rises in the Sahyadris south of Hanuman hill. The river runs eastwards through Baglan and Malegaon talukas. It is joined by a number of effluents especially from the northern side. i.e. Tungadnala, Bhevarinala, Alwainala and Vatolinala. Important among south bank tributaries of the Mosam is the Knagarinala joining at Askheda. Mosam joins Girana near Chandanpuri about 3 k.m. below Malegaon. Panjan and Manyad are eastern most tributaries, which are much larger in size than the other.

Borinadi (river) is an independent tributary of the Tapi, rises a little above Mahad and Chirai on the southern slope of the Galana hills and it has a small course eastwards within the study area.


1.6) **CLIMATE:**

Nashik district experiences moderate temperatures that averagely range from $12^0\text{C}$ to $30^0\text{C}$. Winters are fairly cold and temperatures are known to drop down to $15^0\text{C}$. (Maximum temperature recorded $45^0\text{C}$ and lowest temperature recorded $1^0\text{C}$ at Malegaon). The climate of the study area is characterized by dryness except in the south-west monsoon season. It has a typical monsoonal climate. The climate of Nashik district can be classified as follows.
1) **Cold season** – December to February.
2) **Hot season** – March to May.
3) **South-west monsoon season** – June to September.
4) **Post monsoon season** – October and November.

1) **COLD SEASON:**

This season extends over a period of three months from December to February. It is generally characterized by cool, bracing and dry weather with occasional short spells of moderate rainfall resulting from the storms that originate over the Bay of Bengal or the Arabian Sea. Another feature of this season is that diurnal range of temperature is even exceeding 18 to 15 at times. There are some interesting facts as regards the mean maximum and mean minimum temperatures of the district. It is observed that during winter season there is a sharp fall in temperature which occurs in the district because it is an impact of cold waves coming from the north. The fig.no.1.9 shows the lowest minimum temperature. Relative humidity for selected stations such as Malegaon and Nashik is lower than in other seasons.

2) **The Hot Season:**

The period between March and May is known as hot weather season. It is characterized by spells of excessive heat and drier weather. The temperature of the district is fairly high i.e. above 42°C on the typical hot summer days. The temperature rapidly rises from the month of March and reaches maximum in the month of May, with the mean daily maximum temperature 41°C at Malegaon and 38°C at Nashik. The heat is intense in the height of summer and on some days the maximum temperatures may go above 46°C in the eastern part of the district [locally known as Malmatha] i.e. Malegaon plateau, with comparatively lower elevations. The highest maximum temperature recorded was 46.7°C on May 23rd, 1916 at Malegaon while it was 42.4°C on May 12th, 1960 at Nashik. The lowest minimum temperature at Malegaon was 0.1°C on February 1st, 1929 and at Nashik it was 0.6°C on January 7th, 1945. The latest information of minimum temperature is-1°C at Kundewadi on 1st January 1991.
3) **SOUTH-WEST MONSOON SEASON** (June to September):

It is also known as rainy season. It extends over a period of 5 months. The mean maximum and the mean minimum temperature shows a general decline from June to August as a result of the prevailing monsoon weather. The mean maximum temperature then rises during September and October with the weak erring of the monsoon, but the mean minimum temperature continues to fall through these months. The mean relative humidity also increases from June to August and declines through September and October. The annual rainfall is 1013 mm. The eastern portion experiences drought conditions frequently.

The south-west monsoon ‘breaks’ by about 10th June over a large part of the area in Western Maharashtra and by the last week of June it is usually well established. There are spatial variations of rainfall because of variations of relief.

4) **POST MONSOON SEASON** (October and November):

The climate of Nashik is generally pleasant compared with the climate of Bangalore and Pune. However, in recent years the temperature of Nashik has increased slightly due to deforestation and industrialization. The climate of Nashik is characterized by dryness except in the south-west monsoon season. The year may be divided into four seasons. The cold season from December to February followed by the hot season from March to May and the south-west monsoon season from June to September followed by the post-monsoon season during October and November.

About 88 percent of the annual rainfall in the district is received during the rainy season from June to September. July is the rainiest month. During May, October and November there is some rainfall, mainly in the form of thundershowers.

**Source** :- (Meteorological Department of the Government of India, Poona, Nashik and Malegaon).
TEMPERATURE:-

There are only two meteorology observatories in the district, at Nashik and the other at Malegaon, from where temperature and other climatological records are available. These may be taken as representatives of the climatic conditions in the district in general. The maximum temperature in summer is 42.5°C and minimum temperature in winter is less than 5.0°C. Relative humidity ranges from 43 percent to 62 percent. The climate of the Nashik is generally compared with that of Bangalore and Pune. However, in recent years it is noticed that the temperature is increasing and the rainfall is decreasing due to industrialization and fast deforestation.

After half of February the temperatures rise rapidly till May, which are usually the hottest months. While days are generally the hottest during April with a mean daily maximum at about 40.7°C (Malegaon), 38°C (Nashik), and nights are usually warmer during May or June than in April. On some days the maximum temperature may go above 46°C in the eastern part of the district with comparatively lower elevations. (Table No. 1.2).

With the onset of the south-east monsoon early on the 1st of June, there is rapid drop in the day temperature, but nights still continue to be about as warm as during April and May, and with the increased humidity of the monsoon, are at times uncomfortable. Towards the end of the monsoon season, in September and October, there is a slight increase in the day temperature, but the nights become progressively cooler.

After the withdrawal of the monsoon early In October the nights become cooler, but there is no appreciable drop in the day temperature. December is generally the coldest month with the mean daily maximum temperature in this month 28.4°C at Malegaon and 32°C at Nashik. The mean daily minimum temperature is 12.4°C at Malegaon and 6.5°C at Nashik. During cold season, cold waves affect the district and minimum temperature sometimes drops to the freezing point, though this occurs occasionally.
The highest maximum temperature recorded was 46.7°C on May 23, 1916 at Malegaon. The lowest minimum temperature at Malegaon was 0.1°C on February 1, 1929 and at Nashik it was 0.6°C on January 7, 1945.

The latest recording of temperature at different observatories in the district on 1st January 1991 reveal sudden fall to about +1°C to -1°C. Especially at Malegaon, Kundewadi and Niphad which is at the east and central part of the district, though this was a very exceptional case.

HUMIDITY:-

The air is very humid during the monsoon season. In the post monsoon, cold and summer seasons the air is dry. The summer is the driest part of the year with relative humidity between 20 percent and 25 percent only in the afternoon.

CLOUDINESS AND WINDS:-

The skies are heavily clouded during the monsoon season. In the rest of the year the skies are most clear. Winds are generally light to moderate with some strengthening in wind force during the latter part of the summer season and in south-west monsoon season winds are north-westerly or westerly in south monsoon season. In the hot season winds are from directions between south-west and north-west.

EXCESSIVE RAINFALL AND DROUGHT PRONE AREA:-

The variability of rainfall is very important for agricultural planning. Particularly in the dry track, when rainfall is marginal. In such areas the variations in the amount of rainfall are responsible for either a bumper crop or a total crop failure.

Spatial-temporal variation in the rainfall is a usual feature of monsoon. Table number 1.3 furnishes useful information about rainfall variations. It is revealed from the table that the highest recorded rainfall during the spell of fifty years was less than double the normal values for all the stations in the direct. As for the lowest value it is observed at Malegaon.
Rainfall records of the study area are available for a good network of thirty stations for a long period. The average annual rainfall in the district is 1034.5mm. In the narrow strip of the district in the close proximity of the Western Ghats the rainfall is very much heavier than in the rest of the district. On an average, the rainfall in this narrow strip increases from 2351.6mm. at Peint in the north to 3341.6mm. at Igatpuri in the south. There is remarkable spatial variation in the rainfall distribution [Fig.No.1.6. & 1.7]. The crest, the western margins of the district receives the maximum rainfall. Peint [2351.6mm.], Igatpuri [3341mm.], are all located in the Western Ghats. The precipitation decreases very remarkably from the western edge of the upland towards the east. There is a sharp decline in the rainfall amount over a distance of about 40 km. from the crest i.e. Nashik [835mm.], Dindori [753.1mm.] and Satana [477.3mm.] located in the rain shadow area which receive considerably less rainfall. In the plateau region to the east of the Western Ghats the rainfall in general decreases from the west towards the east with some local variations due to topography, and receives, less than 500 mm. rainfall. [Fig.No.1.6.]

Annual rainfall exceeding 125 percent of the normal is considered as excessive rain. Excess of rainfall generally leads to severe floods and “Wet-famine”. During 75 years periods (1901-1975) excessive rainfall was experienced in Nashik district.

“A period of drought is defined as a year or season in which total rainfall is less than 75 percent of the normal. It may further be classified as a year or season of “moderate drought” if rainfall deficit is between 26 percent and 50 percent and a year or a season of “severe drought” when it is more than 50 percent”. During the 75 years (1901 to 1975) Nashik district experienced five drought years. Considering the period from 1901 to 1950 Niphad and the eastern talukas of the district had such low rainfall during the five years from 1904 to 1908. The period 1920 to 1923 was in general a period of low rainfall over most part of the district. In the period from 1951 to 1981 it is observed that at least the years of 1965, 1966, 1972 and 1973 were characterized by famines. As the figure under references shows a large part of the study area constitutes the drought cold area.
RAINFALL ZONES:-

The rainfall in Nashik district is uneven. Within the district, the monsoon shows tremendous variations. It is not uniform in all parts of the district. The rainfall is high in the western part and decreases towards the east. Broadly speaking, the study area can be divided into five rainfall regions. Rainfall region is determined by different controlling factors such as alignment variations, the alignment of hill and mountain ranges and the rain shadow. The ridge and valley topography adds to the rain shadow effect throughout the area. Though the average rainfall of the district is between 2600 mm. and 3000 mm. there is wide variation in the rainfall received at various blocks. Most of the rainfall is received at various blocks in months from June to September.

The district can be divided into distinct zones according to coefficient of variation. The variability values are as less as twenty percent in the mountainous west meaning thereby that the reliability of monsoon is 80%. However, it falls to 30 percent. It covers the drier tract of the east, where the agriculture is balanced. The variability increases to the east.

Unevenness in its seasonal and aerial distribution causes the problem of regions in suitable zones.

However, on the basis of rainfall returns for the series of years justify the different zones of the region as follows:

i) Western zone of very heavy rainfall
ii) Ghat's zone of high rainfall.
iii) Central zone of medium rainfall.
iv) Eastern zone of uncertain rainfall.
v) The scarcity zone.
i) WESTERN ZONE OF VERY HEAVY RAINFALL:-

This zone comprises the western hilly talukas with 2500 to 3000 m. m. rainfall per annum. The rainfall is relatively heavy and assured. This zone is also called as paddy zone. The boundary of the region is the 2500 m. m. isohyet. However, the region has generally very heavy rainfall as in Igatpuri it is 3341 m.m., Surgana-2926 m. m., Peint-2351.6 m. m. It is also known as the Sahyadrian zone, which receives more than 80% of rainfall during the south-west monsoon season. During June-September the high rainfall and low temperature are the characteristic features. In the month of May the weather is generally dry and hot. However, due to the altitude the severity is not felt. The humidity is very high during rainy season, but is low in the post monsoon period, the cool season and summer.

The Sahyadri Mountain, its higher slopes and windward location make this region, a region of very heavy rainfall. Bounded by 2500 m. m. isohyet, the region is located in the extreme western margins of the area such as western part of Igatpuri, Surgana and Peint talukas.

ii) GHAT ZONE OF HIGH RAINFALL :-

This zone receives rainfall between 1500 and 2500 m. m. The region corresponds to the eastern slope of the Sahyadri and occupies the west central part of Surgana, Peint and Igatpuri talukas. Roughly it lies in a narrow strip. The summer of this zone is mild and cool due to the effect of the altitude. The variation in rainfall entirely depends on orographic influence. Thus, Peint has 2351 m. m. and Surgana 2916 m. m. (Fig. No.1.6).

iii) CENTRAL ZONE OF MEDIUM RAINFALL:-

The central talukas have been included in this zone which have 750 to 1500 m. m. rainfall. This region forms the transition between the high rainfall regions in the west to the comparatively low rainfall region in the east. The region as a whole covers the west central part of Nashik, Dindori, Kalwan and Baglan talukas and also west part of Sinnar taluka. This zone is roughly parallel to Ghats’s zone.
The region coincides with the middle and lower slopes of the Sahyadri. The region comes under rain shadow area and the rainfall variation is greater. Thus Kalwan (751 mm.), Dindori (788 m.m.), Ambapur (Baglan-760 m.m.), some places of Sinnar, Baglan and Nashik talukas receive rainfall between 750 mm. and 1500 mm. The rainfall variability in this region also shows that it lies between 15 percent and 40 percent of the normal rainfall.

iv) ESTERN ZONE OF UNCERTAIN RAINFALL:-

It is also known as the dry zone of the study area. The central and eastern talukas of the study areas come under dry zone. The yearly average rainfall of this zone is less than 750 mm. for example Nashik- 507 mm., Baglan-498 mm., Chandwad- 654 mm., Sinnar- 567 mm., Niphad- 565 mm., Malegaon- 536 mm., Yeola-550 mm. and Nandgaon-566 mm. This region on the whole occupies 65 percent of the study area.

v) THE SCARCITY ZONE:-

It is also known as Mal-Matha. About 40 villages from Malegaon taluka in most of the local region cover northern and north eastern portion of the Malegaon taluka. It receives the rainfall less than 500 m. m. This is a zone of the lowest rainfall. 5 percent of the area is covered by this zone. (Fig No. 1.6 & 1.7)

CONCLUSION:

The amount of rainfall varies from less than 500 m. m. to more than 2500 mm. Most of the region nearly 65 percent area of the study region has rainfall of 500 to 1000 mm. But the rainfall also fluctuates greatly in terms of beginning, spread and as well as amount. Out of the total annual rainfall nearly 80 percent is derived from south west monsoon making it the most influential aspect of climate affecting agricultural land-use of the district.

1.7) NATURAL VEGETATION :-

The forests are found in every tehsil of the district. However, the major area under forest is in the tehsils like, Surgana, Peint, Dindori, Kalwan, Trimbakeshwar and Igatpuri. The area under forest is also one important factor that affects the climatic and rainfall condition of the region. The total forest area in the district during 1979-80 is 3473.19 sq.km. i.e. 22 percent of the total geographical area. In 1989 the area under forest was 327818.60 hectares. As per the new definition of forest the area
under forest in 2004-05 is 260284.64 hectares. There is a reduction in area under forest. The forest produce is divided into two main classes i.e. major and minor. The major forest produce is timber, mostly found in Peint, Surgana and part of Dindori tehsil. The minor forest produce like Tendu, Bamboo and gum etc. are found in large quantity in almost all tehsils. The floristic comparison in the district varies with rainfall, altitude, biotic factors, and local microclimates. The forest types are mainly four viz.

1) Evergreen forest.

2) Semi-evergreen forest.

3) Tropical deciduous forest.

4) Deciduous forest.

1) **Evergreen forest**: -

   This type of forest is found in the western part of the study area, which receives a rainfall of more than 2500mm. annually and supports the evergreen rain forest. Thus in the westernmost part of Igatpuri, Peint and Surgana talukas, the vegetation is mainly evergreen." Rose wood”,” Paan”, “Aini” and “Telsut” are important varieties.

2) **Semi-Evergreen Forest**: -

   This type of forest is observed in the western part of the area having a rainfall 2000 mm. to 3000 mm. It occurs in the narrow strip with north-south extension on the eastern slopes of the Sahyadri. Bamboos, Ain, White kindal, and Hiirada are found in this area.

3) **Tropical Deciduous Forest**: -

   This type is found in the region marked by an annual rainfall of 1000 mm. to 1500 mm. immediately to the east of tropical semi-evergreen vegetation type. The trees in this type shed their leaves for about 6-8 weeks during the hot and dry weather. The trees are between 60 to70 feet high. Teak is the main useful species. The area also has a variety of grasses, the most common of which is Rosh grass, musal, Kunda, Sukal and Teak.
4) Deciduous forest:

60 percent area of the study area is covered by this type. It occurs in the central and eastern parts. This type is associated with areas receiving rainfall less than 1000 mm. It degenerates into shrub type of vegetation where the rainfall is less than 600 mm. Bar, Polati, Nephad, Vagati, are all typical species of this scrub and thorny area. The growth of this species is usually small and stunted. Babhul is also found in this type. The dry deciduous forests occurring in patches and are found in the areas with 500-750 mm rainfall.

FIG. NO. 1.9: NATURAL VEGETATION
1.8) **SOIL:-**

Soil is one of the factors that determine the fertility of land and the crop to be taken in the region. “Soils constitute the physical basis of an agricultural enterprise and play a very important role in the agricultural economy of a region. Differences in soil texture, drainage and fertility are of major importance in explaining contrasts in agriculture. COPPOCK-1964). Unlike climate, however, soil differs considerably within short distance. In many parts where topography shows sharp irregularities in the slope of the land it is not uncommon to find bare rocks lying adjacent to depressions cored with deep soil, while in between there may be hill slopes and even plateau tops covered with stony rock as in the west part of the district. Agricultural productivity is the result of interrelationships among a number of growth factors and soil is one of them. Knowledge of soil productivity and fertility is an essential prerequisite for its agricultural use. Soil productivity is the capacity of the soil to produce plants under a specified program of management. Fertility is defined as the potential of a soil for supplying nutrient etc. in amount and proportions required for ideal plant growth. Generally highly fertile soil should be productive but this is not necessarily true in all instances.

Nutrient loons occur in the soil in mineral or organic compound absorbed to exchange surfaces and in the soil solution. The soluble and absorbed nutrients are extracted readily by plants roots. There are sixteen elements essential to plant growth. The major elements are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and Sulphur, while minor elements include iron, copper, manganese, Zink, molybdenum, chlorine boron.

Methodological difficulties are involved in studying the soils of the region. For they have not yet been scientifically surveyed. Even if one tries to connect the officers in the Government Soil Department or Department of Agriculture, as the author did during his field-work at several places, substantial information was not available. Therefore the discussion on soils is a generalized one and based largely on government of Maharashtra publications (district Gazetteers, District Census book). The characteristics and the distribution of soil in Nashik district are influenced essentially by the nature and intensity of weathering and mode of rapidity of fluvial transports.
The topographical variations, climatic differences, especially amount and period of rainfall and drainage of the area under study are the important environmental factors influencing the formation and characteristics of soils.

Predominantly four major soil zones are identified in the area. The classification generally depends upon special variations of rainfall and relief features. (Fig. No.1.5)

1) Laterite and lateritic soil.
2) Reddish brown soil.
3) Medium black soil.
4) Deep black soil.
1) Laterite and lateritic soil:-

Laterite and lateritic soils cover roughly nine percent of the total geographical area of the district occupying 90 percent area of Peint and percent area of Surgana taluka. The warm humid climates and the forest vegetation have accounted for these types of soils. They are derived from the basalt rocks. The heavy rains in the region thoroughly leach the soils turning them acidic in reaction and devoid of calcium carbonate. Although they are rich in sesquioxide, these soils are generally poor in their contents of phosphate and potash, the two important oil nutrients. Hence these soils are very poor in fertility. However, the soils from the forest region are well supplied with nitrogen and organic matter.

Further, these soils are located on the high reaches of the western Sahyadris and are under constant leaching. But the degree of laterisation is not the same everywhere and varies greatly according to the intensity of the rainfall.

These soils vary in color from red to brownish red (due to the preponderance of hydrated iron oxides) and are loamy in texture (Fig. no.1.5).

2) Reddish brown soils:-

These are also known as non-lateritic soils. These soils occur in the western part of the study area of 90 percent area of Igatpuri, north and southern portion of Nashik, 50 percent western area of Dindori and the extreme west part of Kalwan and Baglan talukas of the district. These soils cover 20 percent area of the study region, and are derived from the Deccan trap (basalts) under conditions of intense leaching. They vary in depth from a few centimeters on steep slopes to more than one metro in valleys. They have normally a brown color with a reddish tinge. The soils are formed in the region receiving a rainfall more than 1000mm. annually. The brown soils are comparatively rich and fertile. Generally, they show a granular structure. They are neither acidic nor alkaline and show a neutral reaction.
3) **Medium black soils:**

The medium black soil cover roughly 60 percent of the total geographical area of the district, mostly the central and eastern parts. These soils vary in texture from sandy loam to clay loam and color from light brown to greyish black. They are characterized by their high contents of free calcium carbonate, which may appear as a lime ban or which may be uniformly distributed throughout the profile.

Though these soils show a general similarity in the fundament and properties, there exists a lot of spatial variation in depth and texture. These spatial variations are interlaid due to the variations in relief or local topography. Hence the shallow soils of lighter shades and textures are associated with the ridges. But the greyish black soils of heavy texture are round in the low-lying lands. (Fig. No.1.51)

4) **Deep black soils:**

The deep black soils mainly occur in the north central and the south central parts of the district along the banks of the major rivers and their tributaries. They are dark brown to greyish black in color. The black soils or “regur” genetically range between residual soil with a mature profile and the river born alluvium of the flood plains to which a large amount of alluvium is also contributed particularly on the margins of the valleys where it is likely to interfere with alluvium (Dikshit-1971). Deep black soils have a clayey texture with 40 percent to 60 percent of clay and show a cloddy structure in often laminar with slanting cleavages. The soils are calcareous, neutral to mild alkaline in reaction, high in caution exchange capacity and low in organic matter. The carbonate contents of the black soils range from 0.5 percent to 3.0 percent.

Along the banks of the major rivers and their tributaries are found very deep black soils. They are also derived from basaltic rock. They are more fertile and deeper than the other medium black soils. In the basins as well as on the banks of the master streams of the area such as Godavari, Girana, Kadava, Mosam and Aram are found vast stretches where these deep black soils are observed. Ten percent area of the district is covered by deep black soils mainly of the eastern Baglan, southern Malegaon, Niphad, Nashik and Kalwan (Fig. No. 1.5).
In general, the soils of the high rainfall zone are slightly acidic, low in their contents of soluble salts and nearly free from CaCO3. The contents of exchangeable bases are also relatively low. The soil reaction becomes more and more alkaline from west to east. The total salts also increase in the same manner, showing a zone of accumulation in the lower layers. The exchangeable actions show a similar increase in divalent bases accounting for more than 75 percent of exchangeable actions and in deep phase, there is a tendency towards sodiumisation. The soils are fair in their contents of nitrogen, available phosphate and available potash.

The description and chemical analysis of typical profiles are given below.

DEPTH IN CM:

0-15: Yellowish brown salty clay loam, single grained, friable, slightly moist, black concretions present.

15:30: Dark yellowish brown clay, slightly moist, blacker concretions, yellowish murum, pebbles present. Below 30: Redish murum

Phase: Very deep (Ghoti- Igatpuri

Depth in cm:

0-17.5: Yellowish-brown, clay loam, compact, black and white concretions present.

17.5-50: Greyish brown, clay loam, slightly moist and massive, black and white concretions in increased quantity present.

50-120: Dark greyish yellow, clay loam, more moist and massive, compact, profuse black and white concretions present.

ZONE II: TRANSITION TRACT.

Phase: Medium deep (Dindori taluka)

Depth in cm:

0-22.5: Dark brown clay with reddish colour and hard.
22.5-40: Darker in color, clayey, cloddy, and harder than above, mixed with murum.

Below 40: Disintegrated murum.

Phase: Deep (Dindori taluka).

Depth in cm:-

0-24: Reddish brown clay, clods breaking into grannies, loose murum here and there.

24-29: dark brown clay, friable, granular slightly compact, murum bits present

Below 49: Yellowish disintegrated murum.

Phase: Very deep (Dindori taluka).

Depth in cm:

0-25: Dark brown clay, clods breaking into crumbs, variable, mixed with lime nodules.

25-47.5: Dark gray clay, same as above, murum bits and lime nodules present.

47.5-62.5: Greyish black clay, friable, profound murum bits.

Below 62.5: Same layer continues.

ZONE III: Scarcity tract.

Phase: Medium (Chandwad taluka).

Depth in cm.

0-14: Yellowish brown sandy loam; single grained, friable, mixed with sand.

14-29: Whitish brown sandy Ipam, single grained, loose.

Below 29: Disintegrated murum.

For chemical analysis of the soils in Nashik district.
FERTILITY STATUS OF SOILS:-

Fertility status here refers to the availability of nitrogen (N), Phosphorus (P) and Potash (K), the essential ingredients for the growth of crops. There are about 18 elements which are essential for plant growth. The presence of nitrogen, phosphorus and potash in soil contributes towards higher crop yields. Nitrogen is absorbed in soil from atmospheric air and is very essential, especially in the early stage of crop growth. The nitrogen starved plants are always stunted in growth. Phosphorus also plays an important role in root production, in energy transformation and photosynthesis which effects the developments of crops.

MAINTENANCE OF SOIL FERTILITY:-

Misuse of land in the region by excessive deforestation, overgrazing of hill slopes and monoculture has caused heavy soil erosion in many parts. However, very little information exists about the extent of soil erosion in this region.

Adequate and timely supply of nutrients, which are lost due to continuous cultivation, is one of the several factors influencing crop production. Nitrogen, phosphoric acid and potash are the “big three” which increase the soil fertility. Hence the growth of crops and their production centers round the supply of these “big three” nutrients. Due to high temperature, generally all soil types in the study area have a very low percentage, especially of nitrogen. The response to nitrogen is of a high order provide there is assured water supply. It is here that the area suffers in a large measure. Apart from other measures adopted to increase soil fertility such as crop rotation, use of natural and compost manures etc. the chemical fertilizers with assured and timely supply of water are most important factors affecting the fertility of the soils in the study area.
REFERENCES


2. Government of Maharashtra Soil analysis of Nashik District.

