CHAPTER I
THE REGION: A PROFILE
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Land resources are the most significant natural wealth and their proper utilization is a matter of utmost concern. The use of land is conditioned by the physical environment through determining the land-use. The physical attributes in the region reflect in deciding landuse and cropping patterns. Moreover, environmental conditions give scope to proper use or misuse of land through its management or exploitation. Physical environment provides favourable or unfavourable conditions to determine the development of human activities which again reflect use of the land.

Panchaganga basin is gifted with a favourable location in terms of natural resources and cultural heritage alike. Kolhapur - a central place in the basin - was the capital of Maratha rulers, who have developed the region with their foresight (Patil, 1950). The dam was constructed across Bhogavati river near Radhanagari by Chh.Shahu Maharaja in pre-independence period, ensuring perennial water supply to the flood plains which have flourished as sugarcane and 'gur' bowls of the State. The basin is endowed with rich soils with accumulation of silt and is well known for sugarcane cultivation.

1. LOCATION:

The Panchaganga basin lies between 16°19'04" and 16°55'19" North latitudes and 73°44'08" and 74°42'18" East longitudes. Located in south Maharashtra, it constitutes parts of Karveer (521.76 sq.km), Panhala (399.20 sq.km), Shahuwadi (310.08 sq.km), Bawada (266.24 sq.km), Radhanagari (480.32 sq.km), Hatkanangale (365.76 sq.km) and Shirol (383.04 sq.km) talukas of Kolhapur district. The region occupies 33.06 percent area
in the northern part of the district. The basin is delineated by considering watersheds adjusted to the village boundaries. It is bounded on the north by Warna basin, on the west by the Konkan districts of Ratnagiri and Sindhudurga, on the south by Dudhaganga basin and on the east by Belgaum district of Karnataka State (Fig.1.1). The region itself is a sub-basin of Krishna river system. East-West spread of the basin is about 108 kms and 67 kms in the North-South, giving an areal coverage of 2730.40 sq. kms (0.89 percent of the State's total area). It is included in Pune division for administrative purpose.

2. RELIEF:

The physical setting influences the farm economy and agricultural activities, determining the extent and magnitude of usefulness of arable land for different agricultural activities in the region. Relief exercises a direct influence on landuse and degradational processes through elevation, ruggedness and slope. It also influences farming by modifying the climate and by affecting the ease of cultivation and the degree of accessibility (Singh, 1974). The relief of the region varies markedly from place to place. These variations are due to the geological complexity of the region and varied geomorphological evolutions (Deshpande, 1971). Over a major portion of the basin the landscape is influenced by the 'Deccan Trap'.

Panchaganga basin on the whole is a part of the Deccan tableland with the Sahyadrian scarp forming the most prominent feature along its western boundary. The Sahyadri proper is a narrow crest zone of the divide with a width of 15 to 25 kms (Dikshit, 1971). Stream erosion
has broken it at several places on both flanks. The height of the crestline varies from 516 to 914 metres which has been literally pushed back to plateau features due to stream erosion at many places. Isolated basaltic tablelands have evolved, such as Vishalgad in the north and Gagangad in the central part of the crestline.

Eastward from this gently uneven and mature looking crestline of Sahyadris - the transitional portion of the basin - is marked with several hill ranges emerging from the main range and developing eastward or north eastward (Fig.1.2) (More, 1980). These ranges extend upto 90 kms. while some of them terminate after a short stretch. These flat topped ranges, with steep escarpments on their flanks, carry several terraces. The erosion has carved out river valleys and their tributaries leaving the hard material as residual hill ranges. A laterite capping marks many of these plateau tops and altogether this step like mature landscape has earned the Swedish name 'trape' topography (Gazetteer of Kolhapur district, 1960). A special feature of the ranges is the existence of many gaps and saddles which are traversed by means of transportation. The northernmost range - Vishalgad-Panhala range extends eastwards upto the lower levels of Krishna basin. In the central part, exists the hill range which separates Kumbhl and Dhamani basins while the 'Pal Dongar', the small hill range separates Tulsi from Bhogavati river. The hill ranges extending north-eastward separates Dhamani from Tulsi, while another one Kumbhl from Kasari river. North Duchaganga range marks the southern boundary of the region (Fig.1.2).

The eastern part of the basin is relatively broad, levelled open tract ranging from 500 to 580 metres in height (Shinde, 1973).
Almost all the ranges are separated by intermediate valleys which are developed on the Deccan lava and form erosional remnants. Eastern part notices hills of low height at some places. Thus, physiographically, 'the Panchaganga basin presents considerable diversity' (Deshpande and Bhat, 1954).

2.1 Relief Divisions:

The relief varies from place to place and the changes in relief features are seen in the west-east direction with local variations. The Panchaganga basin can be divided into three broad relief divisions, viz. i) Hills and Ghats, ii) Foot Hills, and iii) Plains (Fig.1.4).

1) Hills & Ghats:

This category includes the areas located in the western part with an altitude of over 600 metres. It covers major parts of Bavada (90.69%), Shahuwadi (84.42%) and Radhanagari (73.45%) talukas, in addition to Panhala (49.38%), Karveer (22.91%) and Hatkanangale (20.68%) talukas amounting to 45.75 percent area in the basin (Fig.1.4.A). It constitutes scarps of the Sahyadris and steep basaltic wall-like cliffs. The crestline of the western Ghats delimits western boundary of this zone which happen to be waterdivide of west and east flowing streams. This zone is inaccessible due to steep slopes, narrow 'V' shaped valleys and rugged topography. The passes and saddles in this division bridge the communication link between this region and adjoining areas. Quite a large part of this division is under evergreen and deciduous forest cover. The important historical forts and places like Vishalgad, Panhala, Vadi Ratnagiri, Durg Manvad lie in this division.
ii) **Foot Hills:**

This division with an altitude of 540 to 600 metres lies eastwards of Ghats. The eastward offshoots run to the east, parallel to the river valleys, forming alternative ridges and valleys from north to south. The average gradient in this zone varies from 5 to 22 metres per kilometre (Groundwater Survey and Development Agency, Government of Maharashtra, 1982). Foot hills constitute a major relief feature in Karveer (26.13%), Panhala (44.69%), Hatkanangale (28.22%) and Radhanagari (19.75%) taluks accounting for 22.58 percent area in the region (district average 33.10%).

The area is covered by monsoon deciduous forest in the western portion and open scrubs, grasses in the central part. Eastwards from Ghats the river valleys are broadened which are favourable for cultivation.

iii) **Plains:**

The areas having an altitude below 540 metres is included in this division. The major portion of this zone is drained by the rivers oriented towards east forming well fertile and cultivated tract, which is formed by deposition of silt. This division covers the major parts of Shirol (92.02%), Hatkanangale (51.10%) and Karveer (50.96%) taluks with narrow ribbon-like patches in Bawada, Shahuwadi, Radhanagari and Panhala taluks (Fig.1.4.D). The gradient of the land in this division varies from 0.58 to 3.2 metres per kilometre and within the lowlands, the slopes are rarely steep. These plains are endowed with favourable conditions and are prospe-
-rous in terms of agriculture. They are benefitted by rich soils, accumulation of annual silt, and development/irrigation, etc. They, however, have become vulnerable to misuse and overexploitation of resources leading to the degradational hazards during recent past.

The analysis reveals that the proportion of level land is relatively small (30.67%) in the Panchaganga basin and is confined to Shirol, Hatkanangale, Karveer and Panhala talukas. Foot hills occupy 22.58% of the total geographical area and are mainly situated in parts of Panhala, Karveer, Rachanagari, Hatkanangale and Shahuwadi talukas. The major part of the basin land (45.75%) is rugged and hilly having little or no use in terms of agriculture.

2.2 Slope:

Slope influences agriculture in the form of the restraint on cultivation and accessibility (Singh, 1984). It influences indirectly the watertable, development of soil, drainage, intensity of erosion process, cultivation practices and irrigation. Generally, steep sloping areas cannot be brought under cultivation. Even on moderate slopes, it is difficult to maintain fertility of soil due to accelerated erosion by cultivation and tillage practices. Slope can accelerate or restrict the pace of degradational process and erosion intensifies with increasing degree of slope. Increase in slope tends to decrease the areal extent of cultivation, while inaccessibility due to very steep slope at places can put all the developmental efforts in a reverse gear.
Five broad categories of slope are observed. They are: i) Very steep slope, ii) Steep slope, iii) Moderate slope, iv) Moderately gentle slope, and v) Gentle slope (Fig.1.3).

i) **Very steep slope:**

Areas with more than 600 metres slope per kilometre cover the western hilly parts of Shahuwadi (14.96%), Radhanagari (10.79%), Panhala (10.58%), Bawada (6.73%) and western Karveer (1.69%) talukas (Fig.1.3). Most of these areas fall either in escarpments of plateau or in the flanks of hill ranges on both sides, highly prone to erosion.

ii) **Steep slope:**

The areas between 300 to 600 metres slope per kilometre occupy 22.07% area of the basin. This zone includes the hilly, rugged parts of Panhala (49.06%), Shahuwadi (58.36%), Radhanagari (23.77%), Bawada (26.08%), Karveer (5.25%) and Hatkanangale (4.15%) talukas. The area is not suitable for agriculture and is dotted with patches of forests. Field observations revealed that clearance of forests has exposed these slopes to excessive erosion.

iii) **Moderate slope:**

The areas of 150 to 300 metres slope per kilometre are grouped in this zone, covering 16.14% portion of the basin. It confines to the rolling lands of river valleys on both the flanks and occupies parts of Radhanagari (40.34%), Bawada (44.23%), Karveer (14.99%) with small patches in Panhala (3.61%), Shahuwadi (7.28%) and Hatkanangale (3.73%) talukas. This area once covered by forest is now encroached by agriculture.
iv) **Moderately Gentle slope:**

The areas, with 80 to 150 metres slope per kilometre, are included in this category, covering 26.50% area of the region. It constitutes major parts of Hatkanangale (52.14%), Karveer (33.30%), Shirol (18.92%), Panhala (21.00%), Bawada (22.60%), Shahuwadi (19.40%) and Radhanagari (16.76%) talukas. The narrow river valleys of the western portion and adjoining areas of flood plains in the east are covered by this division. Most of the area is suitable for cultivation where a variety of crops are grown.

v) **Gentle Slope:**

The areas having less than 80 metres slope per kilometre fall in this group covering 28.16% area of the basin. This area includes the flood plains in the vicinity of streams occupying most of the eastern and central basin areas. These include parts of Shirol (81.08%), Karveer (44.77%), Hatkanangale (39.98%) and Panhala (15.75%) talukas; in addition to the small patches along the streams in Bawada (0.36%) and Radhanagari (2.73%) talukas.

3. **DRAINAGE:**

The well developed drainage pattern of the Panchaganga basin is geared to the base level of the Krishna which has mastered all the river courses of the basin (Gazetteer of Kolhapur district, 1960). The general drainage pattern seems to be of trellis type, noticed along the sub-parallel river valleys separated by hill ranges in Radhanagari, Bawada, Panhala and parts of Karveer talukas. The northern part of the
basin, particularly Shahuwadi and northern part of Panhala talukas, has dendritic pattern whereas parallel pattern is seen in Radhanagari taluka to the north of Laxmi Tank and in northeastern corner of Panhala taluka. Isolated hills in Karveer and Shahuwadi talukas have resulted in radial pattern where streams radiate from central elevated hills in all directions. Eastern part is covered by dendritic pattern. The variation in drainage appears to be related to relief.

The Panchaganga river, a tributary of Krishna along with numerous affluents and distributaries with 447.5 kms. of total length, constitute the principal drainage system. The stream length in the region is 0.164 kms. per sq. kilometre of geographical area. Panchaganga commands a large area through its main tributaries, namely the Kasari, the Kumbhi, the Dhamani, the Tulsi, and the Bhogavati. It is formed by the meeting of tributaries at Prayag (Fig.1.1) in Karveer taluka and meets Krishna at Narsinhwadi (Shirol taluka). Panchaganga, with total length of 66.50 kms., flows west to east with minor diversions, enjoying the catchment area of 904.08 sq. kms. onwards from Prayag. The local tradition believes that 'the Saraswati' is an underground stream which altogether results in meeting of 'five' (Panch) streams (Ganga) known as 'Panchaganga'. The river is a perennial source of water supply. The area along the river is 'benefitted by unparalleled sedimentation and has developed into some of the most productive areas in the State' (Dikshit, 1986).

The Kasari, an important tributary of Panchaganga drains major parts of Shahuwadi, Panhala and Karveer talukas. Source point of the river is at Gajapur in Shahuwadi taluka in main Sahyadrian
ranges and meets Bhogavati at Prayag with total length of 55 kms. It has triangular catchment area of 675.04 sq.kms. The Bhogavati, flowing from southwest to northeast, occupies the areas of Radhanagari and Karveer talukas. It takes its rise at Asane in Dajipur sector (Radhanagari taluka). The dam is constructed near Radhanagari, creating a huge reservoir (Laxmi Tank) regulating water through the river course during dry season keeping this river perennial. It meets Kasari at Prayag covering 86 kms length and catchment area of 534.72 sq.kms. Bhogavati plays significant role in fulfilling the power and irrigation needs of the region. The Kumbhi, starting from Sambarkund in Radhanagari taluka, meets Bhogavati near Bahreshwar in Karveer taluka. It covers parts of Bawada, Radhanagari, Panhala and Karveer talukas, with the length of 54.50 kms and 269.60 sq.kms. catchment area. It faces water scarcity during dry seasons and becomes very sluggish. Irrigation is practised through small barrages in later stages. The Tulsi, a small tributary of Bhogavati, originates at Durg Manwad in Radhanagari and runs through Radhanagari and Karveer talukas to meet Bhogavati at Are in Karveer taluka. It has 36.50 kms. length and a small catchment area of 162.72 sq.kms. Tulsi runs through an open valley, increasing depositional capacity of the river and hence, there are relatively wide patches of flood plain along its banks. The Dhamani, a tributary of Kumbhi, has origin at Bhatwadi (Dajipur) in Radhanagari taluka having the length of 43.50 kms. It flows southwest to northeast to meet Kumbhi near Longhe in Bawada taluka running through Radhanagari, Bawada and Panhala talukas. It has a catchment area of 186.24 sq.kms. Both these rivers face acute water scarcity in dry seasons.
These rivers have developed flood plains and terraces, which are highly fertile, locally known as 'mali'. These areas are benefitted by developed water supply and rich soils in terms of agriculture. These productive and fertile soils are occupied by sugarcane which are annually renewed by rich sediments, silts at the time of flooding. The physical setting of these river valleys has facilitated construction of Kolhapur type of weirs, locally known as 'Kolhapuri Bandhara', providing perennial irrigation.

4. **CLIMATE:**

'Climate can affect the choice of a farming system either indirectly through its influence on soil formation, or directly through such factors as the length of the growing season, and the availability of water for plant growth' (Mitra, 1980). It, also, is one of the major determining factor in the process of land degradation. It can accelerate or check the process. It would, therefore, be worthwhile to analyse the important climatic variables which control the cultivation and degradation of land to an extent.

Climatically, Panchaganga basin can be divided into two zones comprising the western hilly tract of Sahyadri and its spurs with river valleys, and the plain, levelled and broad eastern tract. Most of the basin region enjoys moderate type of climate with very little extremes of heat and cold (Shinde, 1973). The western part of the region is relatively cooler than the eastern plains due to the influence of sea breeze. The nights are cool and pleasant and range of temperature is comparatively small in the western hilly tract. During rainy season, the west receives
heavy rainfall and the weather is always humid. While in summer, the hill tops temper the prevalent hot winds keeping the climate pleasant. The heat generated during summer months causes occasional heavy showers attended with easterly winds. The climate of the region is, thus, pleasant and agreeable during greater part of the year, particularly in the western hilly tract. The entire tract is located in the rainshadow zone of Western Ghats receiving a decreasing amount of rainfall from west to east. Great annual variations in precipitation are rare but it is unevenly distributed.

4.1 **Temperature:**

Temperature conditions are generally less erratic from year to year than rainfall conditions and hence not a significant consideration in plant growth as compared to rainfall. However, annual ranges in temperature may be of significance in determining the various facets of agriculture. On the whole, the region experiences adequate warmth and bright sunshine throughout the year to provide ripening conditions for crops. The mean daily maximum and minimum temperature in the region is 30.9°C and 19.0°C respectively with a small daily range of temperature. Table 1.1 shows mean monthly maximum and minimum temperature and relative humidity conditions, representative of the region.

The change in season is a fundamental feature of the climate and agricultural operations are closely associated with it. Table 1.2 represents the characteristics and duration of seasons revealing the prevailing conditions of temperature in each season.

The hot dry season, prevailing in the months of March to May, has the hottest months, particularly in the eastern tract with a mean maximum
TABLE 1.1
Maximum and Minimum Monthly Temperatures and
Relative Humidity in the Panchaganga Basin.
(Centre - Kolhapur).

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Temperature 35.8°C, 36.3°C and 37.2°C respectively. Summer maximum temperature rarely exceeds 38°C (Shinde, 1973). The mean daily temperature varies from 18.8°C to 22.2°C. The diurnal variation of temperature is high and mean value ranges from 17°C in March to 12.6°C in May.
The mean relative humidity in this period is 65 percent in the morning and 25 to 40 percent in the evening. Low values of humidity are noticed in the afternoon. The prevailing wind direction is mainly westerly with the occurrence of easterly winds in the afternoon. The region receives isolated rainfall accompanied by thunderstorms in these months particularly in April and May.

The monthly maximum temperature in June, July and August is 29.8°C, 26.7°C and 26.1°C respectively. Again in the month of September temperature begins to rise. Moisture content is generally high and air is nearly saturated in these months having relative humidity ranging from 88% in the morning to 79% in the evening. The direction of winds during this period is mainly westerly. These months notice warm and wet season.

The cold dry season from November to February notice the steady decrease in temperature and mean maximum temperature ranges from 15.2°C to 16.3°C. December and January are the coldest months of the year with 15.6°C and 15.2°C minimum temperatures. The lowest temperature of individual days may go down to 10.3°C. The range of temperature is rather large, averaging 15.5°C in the months of January and December. The mean relative humidity for the season is 64 percent in the morning and 32 percent in the evening. Thus, the cold season is marked with low temperature and moderate humidity.

Fig. 1.6.8 shows the variations of temperature from normal for the period of 1961 to 1984; revealing the fact that there are no major variations in the temperature.
4.2 Rainfall:

Rainfall is the dominant single weather element 'influencing the intensity and location of farming systems and the farmer's choice of enterprises' (Singh, 1984). The insecurity, variability, meagreness and intensity of rainfall, etc. affects agriculture as a whole besides land degradation which demands thorough analysis. In this study, the annual average distribution, annual variation from normal, intensity of rainfall and annual average rainfall variability are discussed.

1) Average annual rainfall:

The basin receives major share of rain from southwest monsoon. Fig. 1.5.A reveals that distribution of average annual rainfall varies widely from 500mm in the eastern portion to over 4000mm in Bawada taluka in the west. The isohyets run from north to south covering about 3/4 part of the region which receives more than 1000mm rain annually. Rainfall is very heavy and assured in Shahuwadi, Bawada, Radhanagari and western Panhala talukas which are hilly. The farming without irrigation has, therefore, become possible in this zone during rainy season. The rainfall gradually diminishes eastwards and is not adequate for farming, necessitating the artificial supply of water through irrigation. Parts of Karveer and Panhala talukas receive moderate and regular rain. The main rainy season in the region is from June to September.

Fig. 1.6.A. shows the average annual variation in rainfall for selected stations in the region, revealing uneven distribution.
### TABLE - 1.2

**SEASONAL VARIATION OF RAINFALL**

**In the Panchaganga Basin (1984)**

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<td>Pancha</td>
<td>343</td>
<td>21</td>
<td>164</td>
<td>34</td>
<td>163</td>
<td>3</td>
<td>140</td>
<td>93</td>
<td>5</td>
<td>9</td>
<td>4</td>
<td>0</td>
<td>1769 76</td>
</tr>
<tr>
<td>Basin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figures in the brackets indicate intensity of rainfall.
*(Sources- 1. Socio Economic Review and District Statistical Abstract for Kolhapur District, 1984-85
2. Compiled by the author.*
ii) **Seasonal distribution of rainfall:**

Panchaganga basin records concentration of rainfall ranging from 77% to 97% from June to September (Table 1.2). July is the month of maximum rainfall throughout the region and after that rain looses its strength by the end of September, giving way to north-east monsoon. The region receives occasional rain during December to February ranging from 1 to 3 percent of the annual rainfall. On the other hand, isolated thunderstorms result in 3 to 7 percent rain in premonsoon months of April and May, particularly in the western part.

Thus, the usefulness of rainfall for agriculture is greatly conditioned by the normal concentration in few months. The rainfall may be quite sufficient to meet the annual water need for successful crop production if it is well distributed and received at the time when required most.

iii) **Intensity of rainfall:**

The intensity of rainfall besides its variation is very significant factor in the context of agriculture and land degradation. It influences erosion process and usefulness of rain for agriculture. The expression 'intensity' is used here as the rainfall per rainy day in 24 hours period (Singh, 1974).

The rainfall intensity varies from 5mm to more than 40mm in the basin. Figure 1.5.B, reveals that Radhanagari and Bawada talukas receive more than 30mm rain per rainy day whereas parts of Panhala, Shahuwadi and central part of the basin receive 20 to 30mm rain per rainy day. The intensity decreases to 10mm or below it in the eastern talukas of Hatkanangale and Shirol. Thus,
VARIATION IN TEMPERATURE FROM NORMAL
1961 TO 1984

Fig. 1·6
the intensity of rainfall is high in the western portion and decreases towards the east. Excessive erosion seems to be associated with the high intensity of rainfall, particularly in western hilly parts.

iv) **Rainfall variability:**

The rainfall variability is measured by the coefficient of variability. The annual coefficient of variability indicates the regularity or irregularity of rainfall. The highest the coefficient of variability, the lower is the assurance of rainfall and low reliability. Fig.1.5.C reveals that the eastern part records more than 26 percent rainfall variability leading to low rainfall reliability. In contrast, the western hilly zone has low variability of rainfall (under 18 percent) indicating assured and high rainfall reliability. The central part records moderate degree of reliability with 18 to 26 percent of coefficient of variability (generally assured). It appears that rainfall is more assured in the western part than in the eastern part of the region.

In sum, the basin receives most of its rain from southwest monsoon concentrated in four (June to September) rainy months leaving the rest of the year almost dry. The annual variation of rainfall from normal is common, and overall distribution of rainfall shows marked spatial differences from west to east. The variability of rainfall is relatively higher in eastern part than in the western part.

5. **SOILS:**

Soil is one of the most significant natural resources and inexhaustible store of plant nutrients on which agriculture depends. Any 'comprehensive survey of the geography of agriculture should include a fairly thorough treatment of soils' (Symons, 1967). There exists a
marked relationship between the production capacity of soils and yield quality of crops.

The soil, through its types, nutrient status, fertility, reaction, texture, structure and other facets, control the cropping scene and productivity of any crop. The availability of plant nutrients depends more or less on the soil reaction, i.e. pH value; which is of immense importance in understanding the rate of nutrient release. These soil properties and characteristics regulate the methods for rational soil development and proper fertilization. Soil characteristics also influence the use of fertilizers, irrigation and farm management practices too. In addition, it conditions land degradation process through the physical and chemical makeup.

The present investigation attempts a study of soils in the context of agriculture and degradation. The soils of Panchaganga basin are mainly derived from trap, except in the forest covered mountainous part in the west where they are of lateritic origin. On the basis of the different physical characteristics, three broad soil zones can be distinguished:-

1) The western hilly and woody zone (with heavy rainfall) is covered with lateritic and reddish brown soils,

2) The central zone with coarse shallow and medium black soils,

3) The dry eastern zone, with precarious rainfall, is covered with black soils of varying depth in the flood plains.
SOIL TEXTURE
Source: Soil survey unit Kolhapur
PANCHAGANGA BASIN
SOIL TYPES
Laterite soils
Reddish brown soils
Coarse shallow soils
Medium black soils
Deep black soils

Fig. 1.7
Fig. 1.7. A exhibits the major soil groups in the region and spatial distribution of various soil types is attempted in the following lines:

5.1 **Laterite soils:**

Laterite soils are derived from the weathering of several types of rocks, laterite in particular, under intermittently moist climate. They show considerable leaching and washing out of plant nutrients. They are porous in structure and red to brownish in colour due to presence of iron. These are mostly eroded and shallow soils with good drainage. Laterite soils are acidic in nature with 5.3 to 6.5 pH range. These are light to very light soils and highly prone to erosion. Laterite soils show a tendency of low water-holding capacity and maximum permeability. They are enriched with nitrogen and potash content but show deficiency in phosphoric content. Sandy loam, sandy clay loam, and loamy sand texture is usually associated with them. These well drained soils are suitable for millets, fruit farming and plantation crops.

The hill tops and ridges in the southwest part are covered by these soils. They constitute 13.41 percent of the total soil cover in the region, mostly in Bawada (88.64%), Radhanagari (21.25%) and a small patch in Panhala (7.13%) talukas. Inferior millets are grown here. Rice is the important cereal grown on these soils, where their depth is relatively more. These soils suffer from erosion caused by running water.
5.2 **Reddish brown soils:**

These soils, derived from trap and dark brown in colour with reddish tinge are rich and fertile with excellent granular structure. These moderately heavy to light soils are almost neutral in reaction showing large acidic soil patches. pH ranges between 5.00 to 7.5; the higher scale being in the vicinity of streams. They witness high to moderate calcium and nitrogen content and are generally deficient in phosphate and potash. They show varying textural composition like loamy sand, sandy loam, silty loam, loam and clay loam. Reddish brown soils record moderate to good permeability but with low water-holding capacity. They are relatively deep, well drained and moderately fertile soils. They respond well to the fertilizers.

This group occupies 30.77 percent of the total soil cover and located in the isolated parts of the hill slopes, mainly in Shahuwadi (92.47%), Radhanagari (57.30%) and Panhala (51.54%) talukas (Fig. 1.7.A). They are usually unsuitable for cultivation at higher elevations whereas in lowland areas rice, jowar and groundnut are grown in kharif season. Sugarcane and vegetables are taken in these soils wherever irrigation facilities are available.

5.3 **Coarse shallow soils:**

These are residual soils and derived from trap. They are somewhat sandy and usually found on hill slopes, foothills, undulating uplands and areas with moderate slope. These are compact and stiff soils with low water-holding capacity. They are well drained, moderate to poorly fertile, granular in structure and neutral to slightly alkaline in
SOIL REACTION AND AVAILABILITY OF PLANT NUTRIENTS

<table>
<thead>
<tr>
<th>pH</th>
<th>Extremely Acid</th>
<th>Strongly Acid</th>
<th>Moderately Acid</th>
<th>Slightly Acid</th>
<th>Neutral</th>
<th>Very slightly/ slightly Acid</th>
<th>Very Alkaline</th>
<th>Moderately Alkaline</th>
<th>Strongly Alkaline</th>
<th>Extremely Alkaline</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>5.0</td>
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<td></td>
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<tr>
<td>6.0</td>
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<td>6.5</td>
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<td>7.0</td>
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<td>7.5</td>
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<td>8.0</td>
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<td>9.0</td>
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<td>10.0</td>
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</tr>
</tbody>
</table>

Source: Thompson (1975)
reaction; pH being 6.5 to 8.00. They witness moderate to low nitrogen, potash and phosphate content; with sandy clay loam to clay loam texture (Fig.1.7.B).

These soils occupy 22.10 percent area in the region, located in Hatkanangale (45.62%), Karveer (39.04%), Panhala (25.94%) and Radhanagari (21.25%) talukas. These are moderately productive soils where groundnut, jowar, pulses are raised, especially when they are well manured.

5.4 **Medium black soils:**

These soils are derived from trap and vary in depth considerably from place to place, depending upon the topographical situations. Away from the stream, they are thin and relatively less fertile than the deep black soils. These are mature but shallow as compared to deep black soils, and are developed on uplands. Their texture varies from sandy clay loam to clay loam with good internal drainage, and have good moisture retentive capacity. Medium black soils are heavy soils with high silt and clay proportion and vary from light black to light reddish brown in colour. They are compact and difficult to plough when dry. They are moderately fertile but give high yields under irrigated conditions. Medium black soils are neutral to strongly alkaline in reaction with 7.5 to 8.3 pH range. They notice moderate to high nitrogen and potash while low to moderate phosphate content.

These soils cover 19.65 percent of the basin comprising the parts of Shirol (47.33%), Hatkanangale (28.56%), Karveer (36.06%) and central part of Panhala (15.39%) talukas (Fig.1.7.A). The soils are good for kharif and rabi crops; jowar, groundnut and pulses in particular.
which respond well to the application of nitrogen and are amenable to irrigation, with good drainage. Paddy, sugarcane and vegetable can success fully be taken in them.

5.5 Deep black soils:

This category represents very heavy soils with higher proportions of clay and organic matter. These are black to dark black in colour and deficient in nitrogen, phosphate content. They show moderate to high potash content and are from clay loam to fine clay loam in textural composition with high silt proportion at places. Deep black soils are moderate to strongly alkaline in nature with 7.5 to 8.5 pH range. These are very fertile soils provided they are supported with water supply. They have high water holding capacity with very poor drainage and are subject to be logged with water under heavy irrigation conditions followed by salt accumulation on the surface' (Thompson, 1978).

These soils are confined to level topography of the basin, sharing 14.07 percent area of the region. Major parts of Shirol (52.67%) taluka and ribbon like extensions along river banks of Hatkanangan-gale (25.62%) and Karveer (16.80%) talukas have these soils. They are intensively cultivated and are suitable for jowar, groundnut, pulses, cotton, wheat and sugarcane.

6. VEGETAL COVER:

Plants have been one of the most useful resources available to man from the earliest time to nourish him, to clothe him, to provide shelter for him and to cure him from diseases, etc. (Meher Homji, 1983). Mankind is benefitted in many ways by forests but man has
POTASSIUM CONTENT
MODERATE
R.A.s.64%

SOIL FERTILITY STATUS
R.A.-26-50 Kg/Ha
K ILO / HECT
HIGH
MODERATE
LOW

PHOSPHORUS CONTENT
MODERATE R.A*223 Kg/Ha
LOW

R.A.=Region Average

NITROGEN CONTENT
R.A.=64%
HIGH
Moderate
LOW

K ILO / HECT
HIGH
MODERATE
LOW

POTASSIUM CONTENT
K ILO / HECT
HIGH
MODERATE
LOW
### TABLE 1.3
Soil types and their Characteristics in the Panchaganga Basin

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Soil types</th>
<th>Characteristics</th>
<th>Texture</th>
<th>Fertility</th>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Laterite Soils</td>
<td></td>
<td>Clay loam</td>
<td>High N</td>
<td>Slight to moderately acidic, pH range 5.3-6.5.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sandy loam</td>
<td>Low P,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Loamy sand,</td>
<td>High K</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Reddish Brown Soils</td>
<td></td>
<td>Loamy Sand,</td>
<td>High to moderate N,</td>
<td>Slight to strongly acidic with patches of neutral, pH range 5.0-7.5.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sandy loam,</td>
<td>Moderate to low P and K.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Clay loam,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Silty loam,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Loam.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Coarse Shallow soils</td>
<td></td>
<td>Sandy Clay loam,</td>
<td>Moderate to low N,</td>
<td>Neutral to slightly alkaline, pH range 6.5-8.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Clay Loam</td>
<td>Low to moderate P and K.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Medium Black soils</td>
<td></td>
<td>Clay Loam,</td>
<td>Moderate to High N,</td>
<td>Neutral to strongly alkaline, pH range 7.5-8.3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Silty Loam,</td>
<td>Low to moderate P,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Loam.</td>
<td>Moderate to high K.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Deep Black soils</td>
<td></td>
<td>Clayey Silt,</td>
<td>Medium N,</td>
<td>Moderately alkaline to strongly alkaline, pH range 7.5-8.5.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Clay loam to fine clay loam.</td>
<td>Low to medium P,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Medium to high K.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Compiled by the author based on soil sample analysis and field traverses, 1987.
TABLE 1.4
Percentage of area under different soil characteristics in the Panchaganga Basin.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Percentage to total geographical area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Látérite soils</td>
<td>13.41</td>
</tr>
<tr>
<td>2</td>
<td>Reddish brown soils</td>
<td>30.77</td>
</tr>
<tr>
<td>3</td>
<td>Coarse shallow soils</td>
<td>22.10</td>
</tr>
<tr>
<td>4</td>
<td>Medium black soils</td>
<td>19.65</td>
</tr>
<tr>
<td>5</td>
<td>Deep black soils</td>
<td>14.07</td>
</tr>
<tr>
<td></td>
<td><strong>Soil Texture</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Loamy sand</td>
<td>9.75</td>
</tr>
<tr>
<td>2</td>
<td>Sandy loam</td>
<td>9.12</td>
</tr>
<tr>
<td>3</td>
<td>Sandy clay loam</td>
<td>12.58</td>
</tr>
<tr>
<td>4</td>
<td>Silty loam and Silty clay loam</td>
<td>9.58</td>
</tr>
<tr>
<td>5</td>
<td>Clay loam</td>
<td>38.66</td>
</tr>
<tr>
<td>6</td>
<td>Clayey silt</td>
<td>9.12</td>
</tr>
<tr>
<td>7</td>
<td>Fine clay loam</td>
<td>11.12</td>
</tr>
<tr>
<td></td>
<td><strong>Soil Fertility</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nitrogen</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>1</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>5</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>6</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>7</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td><strong>Soil Reaction</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Strongly acidic</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Moderately acidic</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Slightly acidic</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Neutral</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Moderately alkaline</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Alkaline</td>
<td></td>
</tr>
</tbody>
</table>

overexploited this vital resource, ultimately resulting in their gradual shrinking. An attempt is made in the present investigation to examine the existing vegetal cover on the basis of visual interpretation of Landsat imageries with field checks.

6.1 Evergreen forest cover:

The evergreen forest is restricted to the isolated patches and ribbon like strips in the western part occupying only 5.33 percent area of the basin. In fact, these strips are nothing but the remnants of rich forest of the past. They are confined to parts of Bawada (16.53%), Shahuwadi (13.78%) and Radhanagari (8.66%) talukas, besides the small patches in Panhala (4.33%) taluka. These occur in western hilly area with high rainfall (Fig.1.10).

6.2 Deciduous forests:

These forests are restricted to the hill ranges, slopes and foothills in the western portion occupying 10.44 percent area of the basin. They cover parts of Bawada (26.98%), Shahuwadi (24.20%) and Radhanagari (16.56%) talukas, in addition to the patches in Panhala (6.93%) and Karveer (5.92%) talukas. These are vulnerable to deforestation and appear to be moderately degraded forests. These two categories together form the real vegetal cover in the basin occupying just 15.77 percent area.

6.3 The Scrubs and Grasses:

About 10.80 percent of the basin area is occupied by scrubs and grasses in the vicinity of existing forest cover in strips or in
isolated patches. They are noticed in parts of Shahuwadi (16.46%), Panhala (12.06%), Bawada (12.02%), Radhanagari (11.99%), Hatkanangale (9.26%) and Karveer (6.26%) talukas, in the form of scrub, scattered and isolated trees, greasses, etc. The hill ranges, once lavishly covered with greenery of thick forest, are now occupied by local low quality grass and sparse trees.

Besides this, forest burns are located in the region occupying 1.43% area, comprising parts of Radhanagari (3.00%), Shahuwadi (2.17%), Bawada (1.80%), Karveer (1.59%) and Panhala (1.16%) talukas. Forests are burnt for ragi cultivation to which 'tarava' (rab) i.e. burning of the field with dung cakes and fire material is associated (Plate 10.B).

The vegetal cover in the region is well below the required average and diminishing at fast rate. The data supplied by Forest Department tells different story but average rate of deforestation in the region is high.

7. WATER RESOURCES:

The water availability for agriculture is one of the essential bases and the foundation of farming (Singh, 1976). The rainfall in the basin is concentrated in few rainy months leaving rest of the year dry. Also the variability factor reduces the effectiveness of rainfall, necessitating to explore other sources of water available for effective and assured supply of irrigation. These sources might be either groundwater or surface water.

7.1 Groundwater:

Very little work is done regarding groundwater in the basin and, therefore, the data pertaining to the aspects of groundwater is
Fig. 1-11
not available. Government of Maharashtra, recently has undertaken watershedwise investigation regarding the annual recharge, withdrawal and potentials of groundwater. The relevant data is abstracted from their reports and used in the present analysis. The assessment of groundwater is viewed in the light of its recharge, withdrawal and potentials in the region.

i) Groundwater recharge:

The addition of water to the zone of saturation in an aquifer is called groundwater recharge (Singh, 1979). The chief source of recharge in the basin is rainfall, as in the other parts of the State. The secondary sources are seepage from streams, rivers, irrigation channels, irrigated fields and sub-soil inflow from surrounding areas. The total annual recharge is considered in this work due to non-availability of sourcewise and seasonwise data. Fig. 1.11.A reveals that the highest recharge (i.e., above 900 lakh c.m.) is noticed in Karveer and Hatkanangale talukas followed by Shirol and Shahuwadi. The recharge varies from 300 to 600 lakh c.m. in Panhala, Bawada and below that in the remaining parts.

ii) Groundwater withdrawal:

The sub-soil water which leaves the area is called discharge. Evapotranspiration, withdrawals by wells and sub-soil outflow to rivers are the main source of discharge (Singh, 1979). An attempt is made here to assess the withdrawal by wells in the region on the basis of data obtained from Groundwater Survey and Development Agency. The sourcewise discharge is not considered due to lack of data. Fig. 1.11.B reveals that the highest withdrawal
of groundwater by wells (i.e. above 400 lakh c.m.) is noticed in Hatkanangale and Shirol followed by Panhala (169 lakh c.m.) and Karveer (123 lakh c.m.) talukas. The highest withdrawal of groundwater seems to be confined to low rainfall areas necessitating the need of irrigation. The lowest withdrawal of groundwater is noted in western part, particularly in Shahuwadi, Bawada and Radhanagari talukas of high rainfall.

iii) Feasibility of wells for irrigation:

The Groundwater Survey and Development Agency, Government of Maharashtra, has surveyed the individual watersheds calculating recharge, withdrawal and balance of groundwater in terms of feasible number of wells and estimated about 298.20 m.c.m. balance of groundwater. Karveer and Shahuwadi talukas represent very high potentials (over 1500 wells per taluka), while 1000 to 1500 wells are feasible in Hatkanangale and Bawada talukas. Radhanagari shows 500 to 1000 feasibility of wells and below 500 wells are feasible in the remaining parts.

iv) Scope for groundwater development:

The study reveals that there is an ample scope for the development of groundwater for irrigation purpose in the Panchaganga basin. The region may be divided into two divisions in the context of further groundwater development: i) the hilly and rugged, comprising the western Ghats and the narrow broken crested ridges stretching eastwards in the central and northern part; the area unfavourable for development; and ii) the eastern plain, level tracts and river banks, the area favourable for development.
7.2 Surface water:

The region has an advantageous position in the context of surface water availability. Panchaganga and its tributaries drain the region with seasonal flow from mid-November to mid-February and become dry from March onwards. They generally overflow in rainy months and face water scarcity in summer. In spite of this, Kolhapur weirs and dams across the rivers have made them perennial providing water for irrigation. The analysis of use of surface water is highlighted in Chapter Three.

It appears that the variability, unreliability and insufficiency of rainfall in the region necessitates to explore water from underground and surface water for irrigation. The total recharge exceeds the total withdrawal in the basin resulting in balance of groundwater; which can be further utilised for irrigation. The substantial amount of surface water available can easily be exploited for irrigation giving a wide room for the future scope for development in irrigation purposes.

8. SOCIO-ECONOMIC CONSIDERATIONS.

Man plays a vital role in modifying and transforming natural landscape. His role as a consumer and transformer is of immense significance in utilizing land resources. Therefore, analysis of relevant socio-economic factors becomes necessary in the present context. It includes an appraisal of demographic factors, size of holding, agricultural implements and livestock pressure, etc. The analysis is based on the data abstracted from agricultural census, population records and other governmental published records.
8.1 **Demographic Factors:**

The distribution of population in Panchaganga basin is closely related to relief, rainfall, fertility of soils, proportion of arable land and irrigation facilities, etc. About 68.07 percent of the people are rural and 31.93 percent urban; in which large portion of population is confined to river banks. The hilly terrain and low proportion of arable land in the western parts have sparse population. The central and eastern plains are densely populated with concentration of urban population in Kolhapur and Ichalkaranji cities.

The population of the basin has increased from 4.40 Lakh in 1951 to 8.02 Lakh in 1981, giving overall growth of 82.26 percent. Table 1.5 shows that population has continued to grow at increasing rate. The main cause of rapid growth of population is the decline in death rate.

There are significant differences in regional distribution of growth rate. Most densely populated talukas of east and central parts noticed higher rates of growth. While the western hilly parts have relatively lesser rates of population growth.

**TABLE 1.5**


<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Decadal Variation</th>
<th>Rate of Variation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>440,367</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1961</td>
<td>534,783</td>
<td>+ 94,416</td>
<td>+ 21.44</td>
</tr>
<tr>
<td>1971</td>
<td>670,788</td>
<td>+136,005</td>
<td>+ 25.43</td>
</tr>
<tr>
<td>1981</td>
<td>802,615</td>
<td>+131,827</td>
<td>+ 19.65</td>
</tr>
</tbody>
</table>

*Source: District Census Handbooks of Kolhapur District (1951 to 1981).*
Density of Population:

According to 1981 census, population was 8.02 Lakhs spread over 2730.40 sq.km. area. This gave the density of population as 386 persons per sq.km. (district average 322). The high density could be explained in the light of sound agricultural base characterised by high agricultural efficiency, agro-industrial development and urbanization. Fig. 1.12.A reveals that Karveer shows highest magnitude of crude density (903) followed by Hatkanangale (702) whereas the lowest crude density is noted in the hilly, rugged Bawada (83) taluka.

The rural density of population is 294 persons per sq. km. in the basin which is highest in the district (247). Shirol (443) and Hatkanangale (442) talukas share the highest rural population and in contrast, hilly Bawada taluka (108) records lowest one. The population densities of eastern and western parts of the basin have great variations.

The concentration of population is noticed in the central and eastern plains which happen to be agriculturally developed areas.

TABLE 1.6

Different Types of landuse densities in the Panchaganga Basin, 1981 (Persons per sq.km.)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Taluka</th>
<th>Physiological</th>
<th>Agricultural</th>
<th>Nutritional</th>
<th>Caloric</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Karveer</td>
<td>424</td>
<td>241</td>
<td>517</td>
<td>757</td>
</tr>
<tr>
<td>2.</td>
<td>Panhala</td>
<td>295</td>
<td>310</td>
<td>530</td>
<td>806</td>
</tr>
<tr>
<td>3.</td>
<td>Bawada</td>
<td>33</td>
<td>185</td>
<td>155</td>
<td>233</td>
</tr>
<tr>
<td>4.</td>
<td>Shahuwadi</td>
<td>128</td>
<td>106</td>
<td>374</td>
<td>627</td>
</tr>
<tr>
<td>5.</td>
<td>Radhanagari</td>
<td>171</td>
<td>199</td>
<td>462</td>
<td>670</td>
</tr>
<tr>
<td>6.</td>
<td>Hatkanangale</td>
<td>442</td>
<td>226</td>
<td>511</td>
<td>738</td>
</tr>
<tr>
<td>7.</td>
<td>Shirol</td>
<td>445</td>
<td>201</td>
<td>467</td>
<td>596</td>
</tr>
<tr>
<td></td>
<td>Region Average</td>
<td>294</td>
<td>271</td>
<td>434</td>
<td>638</td>
</tr>
<tr>
<td></td>
<td>District Average</td>
<td>247</td>
<td>126</td>
<td>397</td>
<td>627</td>
</tr>
</tbody>
</table>

Source: Compiled by the author.
Further, man-land relation is being investigated by computing different landuse densities, i.e. physiological, agricultural, nutritional and caloric densities. The basin's average physiological density, i.e. man-soil density is 294 persons per sq.km. as against 247 district average. Karveer, Hatkanangale and Shirol talukas share the highest physiological density and hilly Bawada, in constrast, notices lowest one. The agricultural density, i.e. ratio of agricultural population to cultivated area is 271 (district average 126) persons per sq.km.; concentration being in Panhala taluka. The overall nutritional density (man-crop land ratio) of the basin is 434 persons per sq.km. (district average 397); varying from 155 to 530. The highest density is noticed in Panhala and in contrast, lowest in Bawada taluka. The basin's caloric density (man-food crop ratio) is 638 persons per sq.km. (district average 627) ranging from 233 to 806. These proportions differ from taluka to taluka in the basin (Table 1.6).

**Population Pressure on Agricultural Land:**

The present study deals with rural population as their livelihood depends upon agriculture. It constitutes a larger portion (68.07%) of the total population and, therefore, an appraisal of the pressure exerted on agricultural land becomes necessary in the present context. It would suggest the intensity of landuse and further would indicate the use and misuse of land.

Population pressure is being investigated by computing the relative coefficients on the basis of standard hectarage namely 0.4 hectare, suggested by the authors of 'Limits of Growth' and quoted by Swaminathan (1974). Using this as a criterion, the unit 0.4047 of a hectare
is divided by per capita land. The quotients thus ascertained give the relative coefficients of over-population. Greater the coefficient, the higher would be the pressure of population on land. A relative coefficient of 1.10 is considered as more or less marginal and only where the coefficient exceeds 1.10, that area may be said to be overpopulated.

TABLE 1.7
Rural Population Pressure on Agricultural Land in the Panchaganga Basin.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Taluka</th>
<th>Rural Population 1981</th>
<th>Cultivated Land (ha) 1981-85</th>
<th>per Capita Land (ha)</th>
<th>Relative Coefficient of Over-Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Karveer</td>
<td>221,136</td>
<td>36,682</td>
<td>0.17</td>
<td>2.38</td>
</tr>
<tr>
<td>2.</td>
<td>Panhala</td>
<td>117,936</td>
<td>19,836</td>
<td>0.16</td>
<td>2.53</td>
</tr>
<tr>
<td>3.</td>
<td>Bawada</td>
<td>28,784</td>
<td>9,665</td>
<td>0.33</td>
<td>1.23</td>
</tr>
<tr>
<td>4.</td>
<td>Shahuwadi</td>
<td>39,718</td>
<td>9,547</td>
<td>0.24</td>
<td>1.69</td>
</tr>
<tr>
<td>5.</td>
<td>Radhanagari</td>
<td>82,250</td>
<td>15,972</td>
<td>0.19</td>
<td>2.13</td>
</tr>
<tr>
<td>6.</td>
<td>Hatkanangale</td>
<td>163,543</td>
<td>28,165</td>
<td>0.17</td>
<td>2.38</td>
</tr>
<tr>
<td>7.</td>
<td>Shirol</td>
<td>169,248</td>
<td>30,281</td>
<td>0.18</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>Region Total</td>
<td>802,615</td>
<td>150,148</td>
<td>0.19</td>
<td>2.13</td>
</tr>
<tr>
<td></td>
<td>District Total</td>
<td>1,835,000</td>
<td>432,816</td>
<td>0.24</td>
<td>1.69</td>
</tr>
</tbody>
</table>


The agricultural landuse data for the years 1981-85 was averaged and centred at 1981 Census population. This gave per capita agricultural land of 0.19 hectare in the basin which is less than 0.4 hectare, i.e. standard hectarage. The relative coefficient of over population worked out is 2.13 (District average 1.69). Table 1.7 reveals that high pressure is common in the entire basin except Bawada and Shahuwadi talukas. The central and eastern plains are under immense pressure of over population. In contrast, the hilly parts of the west record low pressure.
Farm Workers:

The term farm workers includes cultivators and agricultural labourers. The basin records 58.56 percent population engaged in agriculture as against district average of 66.87%. The cultivators dominate (42.96%) the agricultural population in the region. The concentration of farm workers is high in the western parts which happen to be rice and ragi culture areas. The small holdings in these parts have brought farmers closer to the fields. Fig. 1.13.A reveals that, except Karveer and Hatkanangale talukas (the areas of high industrialization and urbanization), the entire basin has recorded high proportions of farm workers ranging from 80.00 to 92.94% of total workers. The large size of holdings, mechanization of agriculture and urbanization, etc. in the central parts, have limited the proportion of farm workers at moderate to low levels.

Figs. 1.12.B and C exhibit almost similar pattern in the distribution of cultivators and agricultural labourers. The analysis reveals that cultivators share a significant portion of farm workers, concentration being in the western hilly parts. The high concentration of agricultural labourers is observed in sugarcane dominating areas where a large portion is required for preparation of sugarcane fields and other activities. The fast urban growth associated with industrialization in Karveer and Hatkanangale talukas have diverted agricultural labourers to manufacturing due to better wages.

Ratio of Non-Farm Workers to Farm-Workers:

The non-farm workers provide services to farm workers and they are a part of occupied ruralities. According to 1981 census, they constitute 41.44 percent of the total workers; giving ratio of 1:1.4 (district average 1:2.1) with the farm workers. Fig. 1.13.D reveals that high ratio is confined to rice and ragi dominating areas of the hilly west. The irrigated sugarcane tracts and areas in the vicinity of urban centres, in the central and eastern parts, notice low ratio (1:2 and under).
Fig. M3

RATIO OF NON-FARM WORKERS TO FARM WORKERS
R. A. = Region Average
R.A=42-96
% TO TOTAL WORKERS
R.A=42-96

CULTIVATORS
AGRICULTURAL LABOURERS
FARM WORKERS
PANCHAGANGA BASIN
1985

PANCHAGANGA BASIN
1985

% TO TOTAL WORKERS
R.A=42-96

FARM WORKERS
AgricultURAL LABOURERS

R. A. = Region Average
R.A=42-96

% TO TOTAL WORKERS
R.A=42-96

0 15 Km

Fig. 113
Rural Literacy:

Panchaganga basin recorded 37.95 percent literacy in which male dominates with 52.88 percent share. The eastern and central parts registered moderate literacy ranging from 41 to 51 percent. In contrast, the western hilly parts noticed lesser portions of literature population.

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Taluka</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Karveer</td>
<td>57.56</td>
<td>24.25</td>
<td>41.85</td>
</tr>
<tr>
<td>2</td>
<td>Panhala</td>
<td>54.05</td>
<td>21.71</td>
<td>38.14</td>
</tr>
<tr>
<td>3</td>
<td>Bawada</td>
<td>35.92</td>
<td>8.65</td>
<td>22.35</td>
</tr>
<tr>
<td>4</td>
<td>Shahuwadi</td>
<td>44.42</td>
<td>15.43</td>
<td>29.17</td>
</tr>
<tr>
<td>5</td>
<td>Redhanagari</td>
<td>51.45</td>
<td>17.97</td>
<td>34.87</td>
</tr>
<tr>
<td>6</td>
<td>Hatkanangale</td>
<td>62.79</td>
<td>33.78</td>
<td>48.86</td>
</tr>
<tr>
<td>7</td>
<td>Shirol</td>
<td>63.99</td>
<td>35.63</td>
<td>50.41</td>
</tr>
<tr>
<td></td>
<td>Region Average</td>
<td>52.88</td>
<td>22.49</td>
<td>37.95</td>
</tr>
<tr>
<td></td>
<td>District Average</td>
<td>55.22</td>
<td>24.19</td>
<td>36.81</td>
</tr>
</tbody>
</table>

Source: Compiled by the author.

The low literacy is confined to the hilly parts of the region and moderate ones to the developed areas which happen to be in the proximity of urban centres and sugar factories (Table 1.8).

8.2 SIZE OF MALE CULTIVATOR'S HOLDING:

The size of holding varies with the pressure of cultivators in cultivated areas. The average size of male cultivator's holding is ascertained by relating number of male cultivators to the cultivated area.
Table 1.9 reveals that the average cultivated area per male cultivator is decreasing from 1.68 to 1.27 hectares in the basin. The increasing pressure of male cultivators and sub-divisions of cultivated lands have led to steady decline in the same. In addition, there is not much regional variation in the average size of male cultivators holding, varying from 1.12 to 1.49 hectares. This certainly makes farming unprofitable and uneconomic. Consolidation of holding has checked further sub-divisions of cultivated land to an extent; but has not succeeded as per expectations.

8.3 LAND OWNERSHIP AND TENURE:

Land ownership is a decisive factor in use of the land resources. The private owner takes positive decisions about the use of land because it is his personal property. This necessitates the understanding of ownership structure of land in the present context. Most
of the land (81.07%) is cultivated by owners themselves (99.19%). Whereas, very small portion is rented in the region. This clearly shows that owner cultivators dominate ownership structure.

TABLE 1.10
Number and Area of Operational Holding by Tenure in the Panchaganga Basin.

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Tenure</th>
<th>Number</th>
<th>%</th>
<th>Area in ha.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wholly owned</td>
<td>88,618</td>
<td>88.19</td>
<td>143,623</td>
<td>81.07</td>
</tr>
<tr>
<td>2</td>
<td>Wholly rented</td>
<td>3,309</td>
<td>3.29</td>
<td>5,946</td>
<td>3.36</td>
</tr>
<tr>
<td>3</td>
<td>Partly owned &amp; Partly rented.</td>
<td>8,557</td>
<td>8.52</td>
<td>27,595</td>
<td>15.57</td>
</tr>
<tr>
<td>Total Holding</td>
<td></td>
<td>100,484</td>
<td>100.00</td>
<td>177,164</td>
<td>100.00</td>
</tr>
</tbody>
</table>


Land Holding Size:

The size of land-holding is an important aspect to augment agricultural production. It determines application of modern farm implements, landuse and intensity of cropping, etc.

The total number of operational holdings in the region are 100,484, accounting for about 177,164 hectares of land. Marginal size of holdings occupy major portion (52.76%), followed by small sized holdings (31.18%). This may be due to adverse terrain in the west and high demographic pressure on agricultural lands in the central and eastern parts. Medium sized holdings (9.16%) are less in number and so are the large sized holdings.

Fig. 1.14 reveals that small and marginal holdings (below 3 ha) occupy most of the lands (70 to 80%) in the basin. The western hilly parts have relatively smaller farms, due to adverse terrain, when
compared to that of the eastern parts. The size of holding is also decreasing due to increasing demographic pressure.

**8.4 AGRICULTURAL IMPLEMENTS:**

The farm implements driven by bullocks and he-buffaloes are ploughs, carts and many others. Table 1.11 exhibits the regional distribution of agricultural implements in the region for 1978 livestock census year.

**TABLE 1.11**

Distribution of Agricultural Implements in the Panchaganga Basin.

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>Taluka</th>
<th>Wooden Ploughs</th>
<th>Iron Ploughs</th>
<th>Carts</th>
<th>Sugar Cane Crushers</th>
<th>Oil Engines</th>
<th>Elec. Pumps</th>
<th>Tractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Karveer</td>
<td>178</td>
<td>14</td>
<td>131</td>
<td>9</td>
<td>42</td>
<td>64</td>
<td>10.01</td>
</tr>
<tr>
<td>2</td>
<td>Panhala</td>
<td>204</td>
<td>1</td>
<td>122</td>
<td>6</td>
<td>53</td>
<td>46</td>
<td>1.94</td>
</tr>
<tr>
<td>3</td>
<td>Bawada</td>
<td>45</td>
<td>0.2</td>
<td>10</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>0.19</td>
</tr>
<tr>
<td>4</td>
<td>Shahuwadi</td>
<td>186</td>
<td>4</td>
<td>54</td>
<td>2</td>
<td>27</td>
<td>11</td>
<td>0.18</td>
</tr>
<tr>
<td>5</td>
<td>Radhanagari</td>
<td>487</td>
<td>1</td>
<td>90</td>
<td>0.80</td>
<td>37</td>
<td>17</td>
<td>2.17</td>
</tr>
<tr>
<td>6</td>
<td>Hatkanangale</td>
<td>42</td>
<td>68</td>
<td>120</td>
<td>1.4</td>
<td>18</td>
<td>137</td>
<td>6.36</td>
</tr>
<tr>
<td>7</td>
<td>Shirol</td>
<td>25</td>
<td>55</td>
<td>98</td>
<td>1.0</td>
<td>8</td>
<td>106</td>
<td>3.78</td>
</tr>
<tr>
<td>Basin Average</td>
<td>167</td>
<td>21</td>
<td>88</td>
<td>3.2</td>
<td>27</td>
<td>54</td>
<td>3.62</td>
<td></td>
</tr>
</tbody>
</table>


**Ploughs:**

Table 1.11 reveals that wooden ploughs are still dominating ploughing which is common in hilly western parts as well as in sugar-cane fields of the east. High concentration of wooden ploughs (above 200 per 1000 hectares of cultivated area) is noticed in Radhanagari (487) and Panhala (204) talukas followed by Shahuwadi (186). The central and eastern
parts, which are dominated by mechanized farming, show moderate to low concentration of ploughs. The iron ploughs are concentrated in black cotton soil tract of Hatkanangale (68) and Shirol (55) talukas where they are necessary for deep ploughing. The central parts, adjoining river banks, recorded moderate, whereas, low concentration is confined to hilly western parts. To sum up, wooden ploughs are more in number in western portion and iron ploughs are concentrated in central and eastern parts of black soils.

Carts:
Carts are unevenly distributed in the basin, concentration being in Karveer (131), Panhala (122) and Hatkanangale (120) talukas. Their significance increases with the proximity to sugar factories, as they are used for sugarcane transportation from cane field to the factory. Moderate concentration of carts (50 to 100) is recorded throughout the basin except in Bawada (10) where adverse terrain limits their utility as means of transport.

Agricultural Pumpsets:
Agricultural pumpsets include oil engines and electric pumps used for irrigation. The development of irrigation and electrification, in central and eastern parts have led to upward trend in number of pumpsets. High density of pumpsets is confined to the sugarcane tracts of Hatkanangale (155), Shirol (114) and Karveer (106) talukas. Moderate concentration is noticed in other parts except Bawada. Electric pumpsets dominate in the east and in contrast, oil engines in the west.
PER 1000 HECTARES OF CULTIVATED AREA
TRACTORS
R. A. = Region Average
PER 100 HECTARES OF CULTIVATED AREA
AGRICULTURAL PUMPSETS
R.A. = 18*80
PER 100 HECTARES OF CULTIVATED AREA
PLoughs
PANCHAGANGA BASIN IMPLEMENTS 1981
Fig. 115
Tractors:

Mechanization of agriculture in the form of tractorization is associated with sugarcane in the basin. The sugarcane growers are able to invest more in such improved implements due to their increased income. It is a common vehicle for the transportation of sugarcane, fertilizers, press mud and organic manures, besides ploughing, furrowing and other farm practices. The number increases with the intensity of sugarcane cropping and proximity to sugar factory. High concentration is confined to the sugarcane belt of Karveer (10.1) and Hatkanangale (6.36) followed by Shirol (3.78) taluka. Tractors are moderately distributed in Radhanagari and Panhala talukas and in rest of the parts, they are less in numbers (Table.1.11).

The other implements like sugarcane crushers, etc. are insignificant in number in the region.

This analysis reveals that modern farm implements in the form of mechanized or electrified ones are concentrated in the sugarcane belt of central and eastern parts. The wooden ploughs, etc.; the traditional implements, are noticed in the hilly west which happen to areas of subsistence farming.

8.5 LIVESTOCK PRESSURE ON AGRICULTURAL LAND:

Livestock are vital farm force in agriculture. The number and types of livestock is influenced by rainfall, irrigation, cropping pattern and fodder availability. More productive areas are practising intensive agriculture wherein livestock are multipurpose in nature. It could be used as farm force and also adds to the cultivators' income through dairy development. But livestock leads to overgrazing due to fodder shortage.
in many areas. Therefore, an appraisal of livestock pressure on agricultural and forest lands becomes necessary in the present context.

Livestock distribution in Panchaganga basin is dominated by buffaloes; she-buffaloes in particular (43.77%) except in Bawada taluka. This could be explained in view of 'operation flood' movement in the region. Buffaloes are concentrated in the central and eastern parts and cattle in the hilly areas of the west. The bovine population dominates throughout the region varying from 113 to 176 per hundred hectares of cultivated land. Sheep dominates bovine population in Hatkanangale (26.36%) and Karveer (20.70%) talukas followed by Shirol (13.68%). Goats are unevenly distributed in the region, the concentration being in Bawada (29.47%) and Shahuwadi (26.28%) talukas. Sheep and goats contribute much in overgrazing in these parts. Other livestock, including horses, donkeys, pigs, etc. are insignificant in the total livestock population.

The livestock pressure on agricultural land cannot be ascertained merely by considering absolute numbers. So absolute numbers are enumerated in standard unit, namely 'livestock unit', having the same food requirement on the basis of animal feed unit. The conversion of absolute numbers into livestock units enables to compare the same with agricultural land (Singh, 1976). Due weightage is given to matured and young stock for their different forage requirement. Livestock exerts pressure on arable, forest and grazing lands leading further to overgrazing which results in acceleration of erosion. The livestock census data of 1976 has been converted into livestock units and same is centred at 1985 agricultural landuse data, which gave per (livestock) capita agricultural land of 0.24 hectare (district average 0.44 hectare). Per capita high values are confined to Bawada (0.65) taluka where number of livestock population is less (Table 1.12).
Fig. 1.16

PANCHANGA BASIN

1981

LIVESTOCK PRESSURE ON AGRICULTURAL LAND

PER 100 HECTARES
OF CULTIVATED LAND

200
150
100
R.A.=183

PER 100 HECTARES
OF CULTIVATED LAND

50
25
0
R.A.=38

BOVINE POPULATION

RELATIVE COEFFICIENTS OF LIVESTOCK OVER POPULATION

R.A.=38

PER 100 HECTARES
OF CULTIVATED LAND

150
100
R.A.=92

PER 100 HECTARES
OF CULTIVATED LAND

150
100
R.A.=183

R.Ai=1 83

PER 100 HECTARES
OF CULTIVATED UND
LIVESTOCK PRESSURE ON AGRICULTURAL UND

Fig.1-16
<table>
<thead>
<tr>
<th>Sr No</th>
<th>Taluka</th>
<th>Cattle</th>
<th>Buffalo-es.</th>
<th>Total Bovine</th>
<th>Sheep</th>
<th>Goats</th>
<th>Other Livestock</th>
<th>Total Livestock</th>
<th>Livestock Pressure</th>
<th>Per Capita Forest (ha)</th>
<th>Relative Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Karveer</td>
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<td>70.38</td>
<td>0.03</td>
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<td>9.91</td>
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<td>52.97</td>
<td>72.02</td>
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<td>Region Average</td>
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<td>43.77</td>
<td>69.67</td>
<td>14.86</td>
<td>14.65</td>
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<td>District Average</td>
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<td>42.46</td>
<td>70.38</td>
<td>13.38</td>
<td>15.66</td>
<td>1.71</td>
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2. Compiled by the author.
Livestock pressure is being investigated by computing the relative coefficients considering standard hectarage, namely, 0.25 hectare suggested in 'Agricultural Situation in India'. Using this criterion, the unit of 0.25 of a hectare is divided by per capita (livestock) agricultural land. Same procedure is followed for computing pressure on forest lands. The quotients thus ascertained gives relative coefficients of overpopulation in terms of livestock. Greater the coefficient, the higher would be the pressure of livestock.

Fig.1.16.D reveals that high pressure of livestock over-population on agricultural lands is confined to the parts of Shahuwadi. Forest areas of Karveer, Hatkanangale and Shirol are under high livestock pressure. These parts notice high density of livestock and less proportion of forest areas. The moderate pressure on agricultural land is confined to central parts. The grazing areas and forests of the central parts are continuously exploited for grazing and are subjected to overgrazing.

The lesser number of livestocks in Bawada taluka results in under-population in terms of livestock pressure on agricultural land; and forests. This certainly indicates the trend of over exploitation of agricultural lands and forests in terms of grazing in the region.

The foregoing analysis of socio-economic factors reveals that the agriculturally developed areas of central and eastern parts are under tremendous pressure of overpopulation. These parts recorded high density of population in which farm and non-farm workers are equally distributed. The density of population and pressure of overpopulation is relatively lower in the western hilly areas. The farm workers are concentrated in the west and in the eastern parts they are equally shared by non-farm workers; due to mechanization of agriculture and vicinity of
urban centres. The nutritional and caloric density is high throughout the region, whereas high physiological and agricultural density is confined to the eastern and central parts. The average literacy is at moderate levels in ruralities of the region in which female literacy is very low.

The average cultivated area per male cultivator is decreasing at fast rate in the region due to sub-divisions of the holdings. Most of the land is owned by cultivators (81.07%) themselves; and marginal and small sized holdings dominate together (83.94%) landholdings in the region. The smaller farms are registered in western hilly parts due to adverse terrain, when compared to that of eastern parts. Size of holding is also decreasing due to increasing demographic pressure.

Agricultural implements in the form of traditional wooden ploughs are used in the western parts, whereas mechanised implements like tractors, electric pumpsets, etc. are observed more in number in agriculturally developed eastern and central parts. Livestock pressure on agricultural and forest lands is noticed throughout the region except in Bawada taluka. This has resulted in overexploitation of these resources and making them prone to overgrazing and erosion in the western parts of the basin.
REFERENCES


5. __________(1986) : Maharashtra in Maps, Maharashtra State Board for Literature and Culture, Bombay, p.27.


