INTRODUCTION

Water is a basic necessity for all forms of life and critical elements of man's activities. It has multiple uses and is considered to be of primary importance. Water is an essential requirement for life health and for nearly all activities of human society. It is, therefore, a vital element in determining the quality of all social and economic development possibilities of any given country. (Un. 1972, p. 18).

In recent years increasing emphasis has been justifiably laid on the keen issues of the water supply problem while the provision of adequate water supplies remains the key to general development in many countries both old and new. It is now recognized that the development of water resources and may be planned in relation to national requirements and strategy in which the proper use of land and other important factors are fully taken into account. Further more the spatial study of water in relation to man is essentially to be conceived as a geographical problem. Which involves the role of such factors as climate Geology, Relief, drainage, rain water, absorption, vegetation, soils and examines the man-environment relationship in general. All these aspects are more directly related to the water supply problems of rural areas where man is primarily in contact with his environment than in the urban areas.

As the population of the world increases the demand for this vital resource is becoming greater with increasing demand of
water. The scientists are paying more attention towards sources of supply management evaluation and utilization in general and problems of scarcity and pollution in particular.

The pressure of demand on the limited supply has been increasing at an ominous rate as more and more people use water not only for drinking cooking purposes but for many other purposes too. With rapidly increasing population much more water will be required for agriculture industry and other uses. The most acute situation is related to agriculture which account for as much as 80 per cent of all fresh water. Between 30 and 40 per cent of the World Food Production is now dependent on irrigation. It takes roughly 1000 tonnes of water to grow one tonne of grain and 2000 tonnes of water grow one tonne of rice. Hence could be said that there is a water problem when demand is not adequately fulfilled by supply. This can occur not only when there is an absolute scarcity of water as in the case of dried areas but also when there is an excess of water as in the case of floods.

The use and development of water resources may be in sufficient due to inadequate domestic water supply. It may be in appropriate, leading for instance to wasteful consumption or the water may be of poor quality from natural causes or through human factor. In most cases several situations interact in a particular area and jointly lead to a complex water problem. Floods can occur in very arid areas or due to poorly drained irrigation scheme and could result in water logging of the fields and salinizations of the soil
and this might occur in combination with an inadequate domestic supply to the farmers.

It would not be correct to assume therefore, that problem arises simply from insufficiency in the quantity or deterioration in the quality of water. In fact quantity, quality and management methods are intrinsically linked. Further more most water problems are themselves directly connected with changes and developments occurring in the human environment such as urbanization, industrialization and agricultural development. Water problem can not therefore, be reduced to the question of the manipulation of natural product or raw material since water itself is a fundamental factor in shaping of environmental system in which it is used.

Usable water is limited in amount and efforts have to be made to find out the best possible uses for the same. This will necessarily involve the determination of priorities of allocation for various uses. The optimum use of water resources involves question of conservation as much as of development and increasing attention is being given to this aspect of the problems as the demand for water grows. With increasing population and greater use of land many surveys have accordingly been made followed by experimental and constructional works with a view to conserving a greater proportion of the rainfall by means of dams and weirs along stream courses. More over absorption of rain water can be increased by appropriate methods of cultivation and of afforestation and also by recharged wells and other so as to affect the replacement of the underlying ground water bodies.
THE REGION

For the study of water resources the river basin is more appropriate the convenient unit of study. Therefore, for the present study the Betwa Basin of Madhya Pradesh has been selected. It extends between 22° 30' to 24° 15' in North latitudes and 77° 30' to 79° 30' East longitude and covers the area of 3722 thousand square kilometers or 8.4 per cent of total area of Madhya Pradesh. Administratively it comprises the parts of 6 districts – Bhopal, Sagar, Raisen, Vidisha, Guna and Shivpuri districts. There are 22 development blocks in the basin. The Upper Betwas Basin consists of 13 sub-basins of its tributaries. There were 303,38 thousand person living population in 1981 and 3662.15 thousand persons living population in 1991 this area. The area has 65.9 per cent net sown area while the area of state 43.94 per cent and 8.0 per cent irrigated area of the blocks. The average 12.5 per cent which is very low per cent than state average.

OBJECTIVES OF STUDY THE REGION

More specifically there is urgent need of water at the same-time it is being wasted under such contrasting situation it is urgently needed to assess the potential as well as need of water resources and analyse the physical social and economic circumstances influencing the assessment and allocation of this essential resource. Though there are several studies on macro level on similar lines studies on micro scale incorporating actual problems and potentials are interestingly absent, the present project is an attempt to fulfil
this gap in water resources studies selecting an agriculturally rich river basin, the problem and prospects of the development of water resources are to be dissected analysed and depicted carto-graphically thus, main objectives of the present study are:

1. To analyse the spatial pattern of water resources potential and its utilization in perspective of physio-socio-economic environments.

2. To assess the costs and benefits of existing as well as proposed uses of water with the objective to suggest optimum use.

3. Since irrigation is the only important use of water in the study area its impact on cropping pattern crop production and agricultural productivity and agricultural productivity is to be analysed in detail.

4. To evaluate the relationship of use of yield raising inputs with the use of water resources.

HYPOTHESIS

Studies pertaining to water resources of this state reveal that both physical as well as human factors influence the use of this precious resource. Among physical factors characteristics of climate and land are important. In comparison to them socioeconomic status of farmers has played a significant role in it usually big farmers with large operational holdings are capable of utilising water for irrigation and other purposes. Under these conditions it is hypothesised that.
1. The potential water resources is directly related with the amount of rainfall but its need is inversely related to it.

2. The use of water is directly related with the amount and variability of rainfall.

3. Use of water for irrigation is directly related with the use of yield raising technologies, viz., high yielding variety of seeds fertilizer and pesticides.

4. At the same time, proportion of irrigation area is controlled by the size and ownership of operational holdings.

SOURCE OF DATA

This study of water resources development will draw data from published and unpublished records and will be supplemented by information generated through field survey utilizing structured questionnaire. For this purpose records of Upper Betwa Basin Resources Development of Irrigation P.H.E. Department of Vindhysachal Office in Bhopal and Office of Ground Water in Bhopal, Vidisha, Raisen, Guna, Shivpuri and Sagar districts will be tapped. These informations supplemented from the agricultural statistics published by the Directorate of Agricultural Bhopal annually and several occasional publications of the Directorate of Land Records, Gwalior. Information on Water Resources are obtained from official reports of the Directorate of Ground Water and Irrigation Department of the State. Sources of demographic materials and District Census Hand
Book and Development and block-wise data have been extracted from the publications of the Director of economic statistics Govt. of Madhya Pradesh, Bhopal.

The micro-analysis of the agriculture development is entirely to be based on the first hand information collected through the structured questionnaires and interview method. In all six villages have been selected. Considering the Crop structure of the basin and LCC farmers are interviewed from these villages, the size and ownership of holdings, use of high yielding variety of seeds, irrigation, use of fertilizer, pesticides, improve agricultural implements and credit facilities.

The results obtained from the mapping and analysis of these information, are to be compared with those obtained from the analysis of official data. Utilizing these two sets of data proposal for integrated water resources planning would be putforth.

METHODOLOGY

There are two common ways of studying water resources, first is the direct study of resources themselves and the second emphasises on commodities produced from them. For the present study, the first approach has been selected. This approach emphasizes the potential contribution of resources and limits of their exploitation. It is useful when the development of unexploited resources is in question and it assists in the contributing development of known resources. As a background to complete the evaluation of the resources. It provides a base for future planning and given clues
to local resources conditions and socioeconomic, cultural, institutional and historical features in response to which the present pattern has emerged. Such resources inventory is one of the primary need for the development planning in lesser developed region.

The adopting this methodology, geographer, rather then economists point of view has been followed. And hence the basic nature of geography as science of areal differentiation and surveys of natural wealth has been kept in mind.

The analysis of the present position and past trends of the use of water resources, viz. climate, Geology, Topography land, water, Physiography, Soil, livestock are to be viewed in the light of the geographical factors. It is seen that water life is the function of data physical and human condition. Therefore, the aim is to see the depth of the impact of these factor on various processes of water resources. And as such most of the relevant data and information are to be collected from various Government Official records. After statistical processing of these inormous data and synthesizing in the forms of tables, diagrammes and maps regional pattern are analysed.

THE SCHEME OF THE STUDY

The present study prises to evaluate the water resources, their potentials, present use and problems in context to regional farm work of the Upper Betwa Basin of Madhya Pradesh. This work will be organised in following chapter.
1. Physical setting—physical factors affecting water resources.
2. Climatic Characteristics.
3. Demographic Determinants.
5. Assessment of Surface Water Resources.
7. Impact of Irrigation on cropping pattern.
8. Non—agricultural uses of water.
9. Strategy for Integrate water resources planning and conclusions.

1. In the first chapter the physical factors which directly effect the occurrence of ground water and surface water have been dealt with. Thus the influence of geology, relief has been assessed. For this purpose, a morphometric character and nature of terrain have been analysed in detail. Then the climatic factors such as rainfall temperature, evaporation, transpiration and evaporation have been calculated to evaluate the potentialities of surface as well as ground water also. This analysis is supported by table maps and appropriate diagrams.

2. In the second chapter various climatic characteristics have been described such as, Solar Radiation, Temperature, Wind directions and Speed, Rainfall, variation of rainfall, Temperature effectiveness, Potential transpiration. These characteristics are ultimately show the water need and water balance of the study
area. Thus water can often be a limiting factor on the specific amount of water.

3. Demographic determinants have affecting water resources development have been analysed in second chapter. It deals in second chapter. It deals with the distribution of population density and social stratification of people particularly proportion of scheduled caste and scheduled tribes their cultural status as revealed by literacy and education participation rate and occupational structure and distribution of ownership and size of operational holdings. There socio-economic factors go long way in affecting the requirement and use of water resources.

4. Assessment of under ground water resources has been carried out in the third chapter. It particularly deals with the ground water reservoirs recharge into ground water reservoirs recharge through well, estimation of total amount, ground water occurrence and movement, Annual ground water increment, fluctuation of water table, Annual ground water discharge, pumping test data, ground water level maps for pre and past monsoon periods are also given.

5. Assessment of surface water resources is the subject matter of the fourth chapter, Importance of surface water, sources of surface water, Factors effecting surface water, Run off of rivers and their tributary and sub-tributaries in the basin, fluctuation of river maximum and minimum discharges. Quality of river water, capacity of irrigation water uses and non uses and wastage potentially of water and farmer attitude, have been discussed in detail.
6. Contemporary status of uses of irrigation water has been analysed in the fifth chapter. The main use of water is irrigation present spatial pattern of irrigation area, growth of irrigation, effect of landuse pattern on irrigation, irrigation and changes in net sown area, irrigation and intensity of cropping, irrigation crops, irrigation by size of holdings and problems of irrigation are discussed in this chapter. Means of irrigation such as well, tank, canal. Tube wells have been analysed in the sixth chapter, particular attention is to be devoted to the irrigation schemes of the study area.

7. How for the present cropping pattern exerts influence on and is influenced by irrigation is the topic of discussion of the seven chapter. Attention is devoted to the spatiotemporal changes in irrigation crops, changes in the areal extent of the crops, relative changes in proportion of crops, changes in production of principal crops, agriculture efficiency, carrying capacity of food cropped, Land Adoption of innovations, irrigation and use of high yielding variety of seeds and chemical fertilizers.

8. Non-agricultural uses of water resources have been analysed in the eighth chapter. Among such uses domestic uses of water, Hydroelectric generation and recreational uses of water are importance.

9. Management of water resources. Planning is proposed to be formulated in the last chapter. It will be tried to accommodate the interests of different segments of uses of water resources with the objective to optimize the acquiring benefits in this strategy.
CHAPTER 1

PHYSICAL FACTORS : (Effecting Water Resources)

Water evaluation is the process of estimating the potential of water or one use or several alternative uses. There are three well established approaches for evaluating water potential (Young 1975). The first is called "the standard approach." In this approach water assessment and planning is regarded as consisting of three phases: description, appraisal and development. The description phase comprises the reconnaissance survey of resources. In discussing the types of information collected it is convenient to use as a framework the major factors of the physical environmental geology, geomorphology, climate, hydrology, soils and vegetation. The second phase, appraisal combines the environmental data with information from technology, while the third phase development is concerned with the physical planning necessary to convert the irrigation potential into production, incorporating social and economic factors. These phases are successive in time. Information collected during one phase is passed on to, and serves as a basis for next. The completion of each phase is marked by the crops production of maps; land forms, soil, forest and other maps showing the physical environment. At the conclusion of the resource survey, water capability maps are prepared according to the suitability of water for different uses. The intensity of survey within this three phase approach is directly related to the scale. For instance a country or a region conducts
a survey at the reconnaissance scale, perhaps a water system survey for resources inventory purposes. The evaluation map derived from this survey is qualitative and shows suitability for major kinds of water use. Out of these surveys samples are drawn for detailed quantitative evaluation and for water development planning. The approach adopted in the present study is that of resource inventory producing maps of these resources and making qualitative analysis of their quantity, suitability and feasibility.

This standard approach of evaluation water resources has been criticized on two counts. First of these is principally concerned with method of resources survey and the second with the place of resources survey in the development process. These criticisms have led to two contemporary functional relationship approach of Moss (1968, 1969). He has proposed a dynamic approach of water resources evaluation based on ecology in place of most static conventional approach based on geomorphology. But he could not suggest a practical survey procedure capable of relatively routine applications to a variety of areas. The second challenge to conventional method is in fact a suggestion that the sequence description evaluation-assessment should be reversed. This was made by Davidson (1965). Davidson argued that most of water surveys have shown little or no development potential for development on economic basis. The alternative approach, which Davidson has suggested that it is rational to search
profitable water use on the basis of demand and then proceed in search of suitable natural conditions for those crops and water uses. This economic approach also misses much of resources data relevance to development. Thus in the routine survey neither the ecosystem nor the economic approach is likely to supplement the standard method of survey described earlier and as such the conventional approach of water resources evaluation has been followed here.

GEOLoGY

In order to study the parameters like physiography drainage pattern, soil and vegetation, Geology plays an important role, this chapter deals with a general description of Geology of upper Betwa Basin, which comprises the formation and lithology.

General succession of Upper Betwa Basin is as follows: Table No. 1.

<table>
<thead>
<tr>
<th>Formation</th>
<th>Age Million Years</th>
<th>Super Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent</td>
<td>0 - 1</td>
<td>Alluvium</td>
</tr>
<tr>
<td>Eocene to cretaceous</td>
<td>100 - 60</td>
<td>Deccan Trap (Basalt and intertrappean sediment).</td>
</tr>
<tr>
<td>Upper pre Cambrian</td>
<td>1500 - 520</td>
<td>Vindhyan supergroup (Sediments and meta sediment).</td>
</tr>
</tbody>
</table>
There are only two geological super groups in upper Betwa Basin, Vindhyan super group and Deccan Traps.

The Bundelkhand granite-gneiss basement complex occupies a very small area in the most northern part of the basin. It served as a base for deep-anatase of Vindhyan sediments.

The general succession of Vindhyan super group is as follows:

**Bhandar Series**: Upper Bhandar sandstones, sirhu shales.

  - Lower Bhandar sandstones, Camurgarh shales.
  - Diamond bearing conglomerates.

**Rewa Series**: Upper Rewasand stones.

  - Jhiri shales.
  - Lower Rewa sandstone.
  - Panna shales.
  - Diamond bearing conglomerates.

**Kaimur Series**: Bhandraul quartzites, scarp sandstones and conglomerates.

  - Nijaiaghar shales.
  - Upper quartzites and sandstone
  - SusnaI breccia.

  - Lower quartzites and shales.
THE UPPER BETWA BASIN

INDEX

- ALLUVIUM
- DECCAN TRAP
- LEMTARADS
- VINDHYAN SENSTON
- BUNDUKHAND GRAINITE

INDEX

Height in metre

- < 400
- 500

scale: 5 0 5 10 KMS
The Vindhyan super group which cover a considerable area occupies two localities one in the north forming north-west, south-east trending liner ridge and the other one which cover Bhopal, Vidisha, Raisen districts in south. In lies of vindhyan rocks in Deccan trap, basalt are also observed in central portion in Sagar, Bina and Rahatgarh. As for as the rock types are concerned, it has repeated sequence of sand stone, shales with lime stone and conglomerates belonging to Bhandar, Rewa and Kaimur groups.

The Deccan traps which is under lain by vindhyan super group may be considered the chief formation of the basin. It covers the central western and southern part of upper Betwa Basin. Basalt is with prominent flow structure. Inter trappean and sediments are present at many places between two flows.

In the central part of the basin, Deccan basalts show greater degree of weathering giving rise to alluvium and alluvium being deposited in undulating relief, while in other parts they show moderate to low degree of weathering, weathered zones show considerable thickness and are only restricted to streams and river courses.

Upper Vindhyan Group

The upper vindhyan group have been divided into three series viz. Bhandar series, Rewa series, and Kaimur series out of which Bhandar and Rewa series are found in the eastern part of the Bhopal plateau and vindhyan ranges respectively. Kaimur series is found in a small portion
near Raisen district. The rocks of Shander and Rewa series are also found in few places of Bhopal plateau and Berasia plain. Total area under these rocks is about only 20 percent of total area of the region.

Shander Series

The upper most division of the vindhyan is the Shander series. Which is separated from the Rewa series by a horizon of diamond bearing conglomerate. The Shander sand stone are fine grained and soft, usually of red colour with white specks when light coloured they often show red streaks. They are fairly thick bedded and yielded large blocks which are used in building. The upper Shander frequently show ripple marks. The Shander lime-stone is of variable thickness and quality passing from a good lime stone to a calcareous shale. The Shanders contain veins and beds of gypsum.

The Shander series consist of the upper Shander sand stones and sirbu shales and lower Shander sand stones, the Shander lime stones and the Ganurgarh shale. This series is mainly found in eastern part of the Bhopal plateau and eastern vindhyan range. The Ganurgarh shales are brick red in colour and are calcareous with stringers of Calcite. They are often ferruginous and show gentle dips.

The Shander lime stone is hard massive and bluish grey, dark grey, pinkish and cream coloured
varieties are also met with the lime stone of variable quality.

It is pure or silicious or magnesian. The lime stone is inter-connected with thin bedded, sandstone shales and quartzites. The beds are horizontal or gentle dipping. The lower Shander sandstone is thin bedding, fine of medium, grained, brownish and reddish brown in colour with whitish or brown spots. At places it is massive. The Siritu shales are thinly laminated and khaki coloured. Some times they are reddish ferruginous and silicified and grade into sand stone.

Rewa Series

It lies in the middle part of the Shopal plateau, Vindhyan range, few places in Sanchi hills and on northern fringe of the Bina plateau. The Rewa series consist of the upper Rewa sandstone and the lower Rewa shales. The upper Rewa sandstone is the prevalent formation of this series. It is a fine grained, hard compact quartzite vitreous sandstone and in colour reddish brown, white, red, pinkish and grey. It is generally massive floggy and thinly laminated varieties are present at places. Ferruginous varieties are also present containing ferruginous nodules. The beds are horizontal or show gently and rolling dips. Current bedding and ripples marks are often found in these sandstone.

The lower Rewa shales are splinatory and in colour they are red, pinkish yellow, brown and white.
Below the shales at places these are a jasperoidal conglomerate, with pebbles of banded jasper and chert in a silicious, gritty and some what ferruginous matrix.

Kaimur Series:

The Kaimur series is found near Raisen town and north-eastern part of Bina plateau and consists of conglomerates at the base and sandstone at the top. The Kaimur conglomerate marks and unconformable junction between the lower and upper Vindhyan. It consists of pebbles of banded jasper, grey, and white cherts. The Kaimur sandstone is generally pinkish in colour compact, massive fine grained and quartztic. The beds are horizontal or gently dipping.

Deccan Trap:

The close of the mesozoic era is marked by the outpouring of enormous lava flows which spread over vast areas of western central and southern India. They issued through long-narrow figures or cracks in the earth crust from a large magma basin and are, therefore, called fissure, eruptions. The lavas spread out far and wide as nearly horizontal sheets. The earliest flows of lava filled up the irregularities of the pre-existing topography. Major portion of the Bhopal-Vidisha district is formed of Deccan traps. The Deccan traps is found in Bina plateau, Berasia plain, Vidisha plateau, western part of the Bhopal plateau and in few part of Raisen. Each flow of trap is
found in the form of plain strata which has thickness between 3 meter to 7.5 meters.

Its margin has the strates of ashes scoria, and green soil, often there are to Archean period when there existed no life on the earth.

Sundelkhand granite and greisses cover the small portion of northern part of the basin. In this basin Sundelkhand granite are represented by grained rocks. The grainitoid are usually pinkish to reddish and grey in colour and medium to coarse grained, usually massive, nonfoliated or weakly foliated. Occasionally the rock is porphyritic with well developed microcline and perthite grains. The weak foliation generally trends in ENE-NSW direction. These igneousplatonic rock is generally grained to granodiorite in composition. Occasionally there are inclusions of quartzite, banded, hematite quartzite. Hornblende chlorite schist and basic dykes long serrated quartz reefs having a general strike direction of IVS-SW-traverse the granite are quite resistant to erosion and thus have formed long-narrow steep walls producing a peculiar topographic feature. They have damed the drainage course to produce, many small lakes. Some of the reefs have shown the presence of basemental sulphides.

Laterite :

These occur in one percent Gairatganj and
Begamganj block in Raisen district as caps of high trap hills. But generally as ferruginous cellular rocks. Capping low lying Deccan trap hills in places surrounded by alluvium. These are used mainly as a road metal. It has most of the characteristics of the typical high level laterite. Shown to be highly alluminous 15 to 20 metres thick and usually in patches less than one and a half kilometre broad by several kilometers long, arranged disconnectedly in rows along old platters of denudation or gently slopes. Each patch usually presents a steep cliff like, face on one side while on the other it finishes flush with the higher part of the slope or becomes covered by alluvium under which it appears to sink with gently dip some laterites have been found to be very highly aluminous.

Alluvium:

Alluvium occurs over a large part of the area particularly along the course of streams like the Betwa, Sagar and Bina rivers etc. It consists mainly of yellow, grey, brown, sandy, clay and contains a large proportion of Kanker as seen near the Basoda, Sironj, etc. Along the Betwa river it often forms steep cliffs in the northern part of the area near Girod the alluvium is about fifteen metres thick.

PHYSIOGRAPHY

The natural resources of an area are greatly influenced by the physiography of the region. It has very important role in framing the set up of extra-territorial
factors bearing on these resources. Thus, if water is an
important resource largely dependent on climatic pattern,
it is physiography that determines the conditions of the
water table, runoff, aquifers etc. which ultimately
determine feasibility of water resource for various used.

RELIEF

Topographically this region can be said to be
the country of plateau, presenting considerable relief.
Generally the slope of this plateau is from south to north
while in western part the slope is towards west. Most of
the area lies 400 to 500 metres above mean sea level. The
southern and western parts of the plateau are above 500
metres from sea level, while in north and east this height
is only 400 metres. There are only some spots may be
called peaks and knots, above 600 metres, from south and
west height decline gradually, towards north and east.
Most of the Khichwara plateau which is situated in the
north-western part have height 500 metres. Vidisha
plateau is situated in east and Berasia plain is situated
in the south to this Khichwara plateau (Plate 3A).

PHYSIOGRAPHIC DIVISION:

For the convenience of analysis the study, region
has been divided into nine smaller physical units on the
basis of relative relief flatness of the land characteristics
profile. There are as follows:

(1) Shivpuri.

(2) Kanu Village.
(3) The Bhopal Plateau.
(4) The Vidisha Plateau.
(5) The Khichiwara Plateau.
(6) The Bina Plateau.
(7) The Sanchi Hills.
(8) The Barasia plain.
(9) The Vindhyan range.

1. **SHIVPURI PLATEAU:** The plateau occupies the south-western part of the Bhopal - Vidisha plateau. The Vindhyan ranges occupy this plateau from south, while the Barasia plain lies north of it. This plateau is bounded by the eastern boundary of Shivpuri plateau. Northern area of the upper Betwa basin is covered by Shivpuri plateau. The plateau is a part of Madhya Bharat Pathar, general elevation of the sea level is of 450 metre to 500 metres. This is folded plateau and some what plain plateau which has no hillocks. By the eastern part the plateau merged in to Rewa sandstone while western of this plateau, there is a valley called Kanu valley by its name. These such plateaus occur in the east the Shivpuri and the Morena separated by an east facing bold scrab formed of sandstones and lime stone of Bhandar age underlain by softer Gamurgarh shales on the eastern part, the slope is 1.5, 2°.

2. **Kun Valley:** Kun valley is the western part of Shivpuri plateau has been carved out of this shale. Further east two other east facing scarps have developed
on sand stone of Rewa and Kaimur ages. General slope of
the valley is towards north-southern part of the valley is
broad and is separated by Shivpuri plateau. General slope
by the slope mapping is of 0°.

Coharganj tehsil is in the east. The width of
the Bhopal plateau gradually decreases from west to east.
In the remote east its width remains only a few kilometres.
From the administration point of view, Hazur tehsil of
Bhopal, and Coharganj tehsil of Raisen district fall. The
average height of this plateau from mean sea level is about
450 metres. The western part of this plateau is composed
of the Deccan trap and the rocks of upper Vindhyan system
of upper pre-cambrian age are found in the eastern part.
The surface of the plateau is undulating with average slope
between 1.0 to 4.5 degree (Plate - 4). Major rivers of
this plateau are the Betwa and Barbati, Betwa after coming
out of this plateau flows towards north east and enters
into the Vidisha plateau.

3. Vidisha Plateau : This plateau is the biggest
physical division of this region. It is bordered by the
Bina plateau, in the north-east, Sagar plateau in the east,
Sanchi hills in South and the Khichiwara plateau, Berasia
plains in the west. This plateau covers entire Vidisha
district and part of Berasia tehsil of Bhopal district.
Only Lateri tehsil and the western part of the Sironj
tehsil are out of this plateau. These latter tehsils fall
in the Khichiwara plateau. The contour line of 450 metres
makes its western boundary. The entire plateau is composed of Deccan trap. From the agriculture point of view this plateau is very important. In this plateau, generally medium black soil is found. The slope of this plateau lies between 0.9° to 4.9°. Therefore, it is intensively cultivated.

The plateau slopes towards north and is drained by a number of rivers. These rivers have formed their valleys between the spur ranges. Most of the Vidisha plateau lies in the valley of the Betwa river, which flows from south to north. This valley is bordered by the Carhi - Teonda range in the east and Khichwara plateau in the west.

On the basis of relief and slope this plateau can be sub-divided into three units :-

(i) The valley of the Betwa.
(ii) The Bina valley.
(iii) The Eastern range.

(i) **Betwa Valley Proper**: The valley extends from south to north in the central part of the plateau and is 50 to 65 kilometres wide. It includes the Betwa valley and the valley of its tributaries - the Besh, Bah, Sagar and the Kethan in the west and the Nin and the Keotan in the east. Coming out of hill chains and ranges. The surface is oven to a gently rolling series of mounds and valleys. Deep fertile black soils derived from the basalt rocks are deposited in these valleys. These have been cultivated
extensively. It is one of the major wheat growing tracts of the Malwa.

The doab formed between the Bah and the Betwa in the south-western part of the plateau is a very fertile and richly cultivated area. Small patches of good land are also available to the north of the Bah, Sambhavad in the west and around Nateran in the east. Further north the valley is not as much fertile in Vidisha and Basoda tehsil as in the southern section. Nearly all the tributaries of the Betwa in Vidisha, except the Bina, Sahodara and Parsari have cut up their banks to varying length and degrees. Nearly all the important grain-trading-settlements, viz. Vidisha, Ganj Basoda, Kurwai etc. are located on the eastern bank of the Betwa.

(ii) The Bina Valley: Although the Bina is a tributary of the Betwa its valley is distinct from the valley of the Betwa by the inter-venting spur of the Vindhyachal, known as Garhi - Teonda range. The Bina valley extends in a narrow belt along the eastern boundary and also included the valley of its tributaries - the Sabnai and the Bagaru, which drain the narrow belt east the forts of Nawab Basoda and Bagrod. The valley of Pathari also over looks the Bina valley. The medium black soil and shallow black soil are found in this area. The slope of this valley area is below 1.0 degree. Its height from sea level is below 450 metres.
(iii) The Eastern range: The Garhi - Teonda range extends from south to north between the valleys of the Betwa and the Bina. It is the most extensive hill range in the plateau and also the most prominent. The height peak of Lakholi (665.7 m.) being located in its southern part other peaks are near Mahau Khera (600 m.), Nawab Basoda (630.3 m.), Teonda (569.3 m.) and Pathari (575.5 m.). Average elevation is 520 m. The geological strata of this area differs from the rest of the plateau in as much as the trap cover, has been removed by the erosion from a large area and the substrata are rich in hard sedimentary rocks, sandstone and limestone of very high quality. However, variation in the colour, texture and quality may be found. The hills and slopes are covered with forests. Gyaraspur is located amidst foot-hills of this range. Basoda, Muhammadgarh, Bagrod, Teonda and Pathari settle near the eastern slopes of the range.

4. The Khichiwara Plateau: This plateau is situated on the north western part of the Shopal, Vidisha plateau. The Vidisha plateau is to the east and the Berasia plain the south of this plateau. It is eastern and western boundaries are marked by 450 metres contour line. Average slope is upto 3.0 degree smooth surface is the characteristics of this trap, are also extended over Lateri tehsil and western part of Sironj tehsil.

This plateau can be divided into following two units.
(i) The Western Range, and

(ii) The Sind Valley.

(i) The Western Range: The western range, a spur of the northern Vindhyachal range has been denuded and disjointed at several points. The range crosses Lateri tehsil from south to north and also forms a table land in the western part of Sironj tehsil. The peak of Chopra near the source of Sapan nadi is 557.8 metres high, that of Lateri is 542.5 metres and Surantal 548.2 metres. The western slope drains into the Parbati nadi. The hills of Kamrari and Mukhar pahar in Basoda tehsil and Hinotia and Saer may also be grouped in this range as its denuded parts. Excepting the north-eastern part of the Lateri tehsil and a few patches of cultivated fertile land, the range is covered extensively with poor quality mixed forests.

(ii) The Sind Valley: The western range and an offshoot from Main was to Surantal make an angle enclosing the upper stream of the Sind and separating their waters from those of the Keoton (and Betwa) in the east and the Parbati and the west. Anandpur settles in the small area of the plateau drained by the Sind. Medium and shallow black soil are found in this valley. Slope of this area is below 3.0 degree. The height of this area of mean sea level below 500 metres.
5. Bina Plateau: The Bina plateau is situated in the north-eastern part of the region. It extends over Khurai and Bina tehsils of Sagar district. It is almost level plateau. It is so smooth that it may be called as the Khurai plain. Because of the level terrain it is easily separable from the Sagar plateau in the south, but it is merges imperceptibly with the Vichisa plateau in the west. The plateau under lain by the traps in most parts extends from south-west to north-east with average elevation between 411 and 427 metres above main sea level. It is almost flat land and average slope is no where more than 1 degree. On the western border of the plateau is Betwa river. This low land is drained by the Jhimpa, Parasora, seasonal Vella and the Bina river, all tributaries of the Betwa. Because of level land and fertile soils, this part is extensively cultivated.

This level area is fairly separated from rest of the district by a series of sleeping rising hills tendency south-west, north-east from Rahatgarh to Pithoria. These hills all over 533 metres above main sea level and etc. As the water shed between the tributaries of the Bina and Jhimpa rivers on one hand and the Ihasan on the other. More than three-fourths of the area of this plateau falls in the Betwa Basin. It is almost homogeneously level tract of black soils. This tract is served by metalled roads and railways. Therefore, it has attracted a large segment of population which mostly settle on the fertile level
cultivable lands. The basin tract may be sub-divided into three parts based on altitude.

(i) The Narain basin (405 - 435 m.) in the east.
(ii) The Khurai plain (above 435 m.) in the Central.
(iii) The Betwa basin (below 435 m.) in the west.

The Narain stream forms a synclinal valley between the Malthon-Sandri hills in the east and the Khurai plain in the west. The Narain stream joining with Sudha nalla, Jhimpa nalla and the Chokra nalla drains the basin. Flowing to north-west it joins the Betwa river.

Dividing the water of the Narain nalla and Bina river and other tributary nalas of the Betwa in the Khurai plain which is slightly higher in height than the basin. It has extra advantage with other river basins that it is easily accessible even in the rainy season while basin areas because of sticky black soils and frequency of rivers remain inaccessible during monsoon seasons.

6. THE SANCHI HILLS: The Sanchi hills are situated on the eastern section of the Shopal - Vidisha plateau. The Shopal plateau abuts this hills from south while the Vidisha plateau lies north of it. This hilly area is bounded by Cairatganj tehsil of Raisen district in the east and the Berasia plain in the west and extends over Raisen tehsil. These hills are composed of hard Vindhyan rocks, surrounded by the much younger rocks of the Deccan trap. Thus the rocks of the Vindhyan system seem as inlies.
Infact, the Deccan traps were deposited on very uneven Vindhyan surface, and by now traps have been eroded from the tops of the pre-existing hills which give the impression of the layers. These hills posses the characteristics of the typical Vindhyan hills. They are most often conical and steep sided. These hills are above 450 metres from sea level. However, peaks are above 500 metres. Betwa is the major river of this region. Flowing towards it reaches into the Vidosha plateau. Many small rivers and streams from east and west join this river. Shallow black soil, medium black soil and laterite soil (Mountain area) are found in this region. The south-eastern part of the Sanchi hills is drained towards south to the river Narmada.

The Bhopal - Raisen road limits a hilly area lying in both sides of the narrow Betwa valley. These hills have been eroded to such an extent that their original alineations have been lost and it is difficult to trace their joints with the main Vindhyan range without crossing a series of valleys. East of the Betwa they show a south to north alingment but west of it they extend south-west to north-east. With the dissected cross sections extending south-east to north-west like the legs of centre pillar. Bhadrachal hill (574.1 m.) located on the western boundary is the highest peak in this region. The famous Stupa of Sanchi is located on one of these hills on the left bank of the Betwa river.
7. The Berasia Plain: Most of Berasia tehsil and northern part of Sehore tehsil come under this physical division. This region is called the Berasia plain. This is the only plain in Bhopal-Vidisha plateau and is situated to the western part of the Bhopal-Vidisha plateau. To the north of this plain lies Chichwara plateau and in south it is surrounded by Bhopal plateau. Vidisha plateau and Sanchi hills are in the east. The area attain a maximum height of 592 metres in Deccan trap hill near Ganakheri village and a minimum height of 431 metres near Bhubanah village. The general slope of the plain is towards Parbati river in the north-west portion and the rest of the area of the plain slopes towards east and it comes in the Betwa basin. The soil existing in the plain is 'black cotton soil' which is formed mainly due to disintegration and decomposition of the Deccan trap. Main physiography of the plain is characterised by the existence of the Deccan trap and Vindhyan hills patches of vindhyan are also noticed in the traps. Since no other formation have been found, it can be inferred that in the area vindhyan are underlying the Deccan traps. The area under investigation is formed by parts of Parbati river of Chambal sub-basin, Bawan river, Bah river and tributaries of Halali river of Betwa sub-basin. From the agriculture point of view the soil of this region is fertile. The slope of this plain is between 1.0 to 3.0 degree.
8. **THE VINDHYAN RANGE**: The vindhyan range is situated on the southern fringes of the Bhopal-Vidisha plateau. Its width increases from west to east. Its average height from sea level is about 15 to 25 kilometres wide, runs through the plateau from east to west sending numerous spurs. In the western part of the Raisen district the hill enclosing the narrow valleys of the Jamner, Barma, Chiklod, Kalan and the Palakmati from four hill ranges, alternating with these valleys and extending more or less in an east-west direction. These lies parallel to be main vindhyan range north of it and the latter two of these also form the water parting line between the Narmada (through the Barma and its feeders and the Ganga drainage system). The highest peak to the north of the Jamner valley is 616 metres. The second range lying between Kaliakheri and Chiklod Kalan is about 486 metres high and runs for a short distance. Ashapuri (459.9 m.) a place of archaeological importance, is located on its western most point. This range and the third one extending from Bhojpur (428.5 m.) to near Chamdpur (Sultanpur) enclose the small valley of Chiklod Kalan. A peak to the west of Kansa is 1.6 metre on this range. The fourth and the northern most range runs west to east and forms the main watershed line.

9. **THE SAGAR PLATEAU**: To the southeast of the hill-chain extending from Rahatgarh to Pithoria lies an elevated plateau called the Sagar plateau. In the south, it is separated from the Narmada valley by a steep escarpment forming the water divide between rivers of the
Yamuna drainage system and the Narmada river system. Eastern border is not so well defined as the southern border however, sudden drop in altitude just east of the line extending from joining Deori and Garhakota may be taken as its eastern limit. This drop in altitude clearly separates the Sagar plateau from the Sagar valley. In the north, it is marked by the Morhat scarp and the Bijwar hills. Physiography of this plateau is characterised by the presence of alternative river valleys and hill chains. There are five river valleys parallel to each other confined in this plateau. The Ihasan river is a tributary of the Betwa and has its source near Jasgrati peak (23° 30' N and 79° 30' E) just south of Sultanganj in Raisen district. Flowing north-wards, this river formed a wide valley between two hill chains one extending from Jasgrati to near Rahatgarh and to Parsoria further north separates it from the Bina river and another extending from Jaisinagar towards north east through Sagar and Banda to Lichora separates the Ihasan valley from that of the Bewa in the east, which is a tributary of the Sonar river. These hills are flat-shaped and frequently attain height of 600 metres. One of them, quite close to Sagar is Pithoria (626.26 m.). Also there are several hillocks of older sand stones amidst trap country, specially around Sagar (West and Choubey, 1964) on the gap of this hill-chain is situated the city of Sagar, which draws is supply of perishable goods from the Ihasan valley in the west.
The drainage of the plateau is directed towards north and north-east. The five big rivers of the area viz. the Bina, the Ihasan, the Bewas, the Sonar and the Beams are all perennial rivers. They are joined by a number of small tributaries, most of which are only wet weather hill is coming down the intervening ridges and joining the main streams at an acute angle. This gives typical dendritic character to the drainage system. Apart from this, certain local features of drainage may be noted here. For example there are plains of relatively high elevation from where, ground slopes down in all directions there is a tendency for water to flow down-words from such points and branch out to different directions, examples may be seen in the large village of Jaisinagar. It is obvious that during the long time separated to the agencies of erosion since the spread of the Deccan lavas, the various hills of the main streams must have steadily cut back into the water divided. It is for this reason that one finds narrow sloping water parting between the above mentioned five main streams of the district. With further passage of time the ridges might recede further towards the local summit, west and Chourey (1964) who have carried out a study of the geomorphology of the neighbour of Sagar plateau.

Considers the following three phases to be involved in the original of the drainage pattern.

(i) The formation of the original pre-Deccan trap
drainage developed on the vindhyan which must have been blotched out at the time of seccan trap volcanic erruptions.

(ii) The development of a new drainage on the top of the trap, the close of the erruptions.

(iii) The tendency for this new drainage to revert to earlier pattern as vindhyan topography become exposed by the denudation of the over lying traps.

1.3 Morphometric Analysis:

Morphometry may be defined as the measurement and mathematical analysis of the configuration of the earth's surface regarding the slope and dimensions of its landforms and the feasibility of river water.

The main objective of the morphometric analysis in this study is to measure the altitude, slope profile and texture of land, as well as the various characteristics of rivers in the drainage basin of Upper Betwa Basin. The understanding of drainage basin nature in terms of its geometry, landscape evolution, relation of various controlling factors of nature climatic lithology etc. in the evolution of land scape and comparision with other river basins are usually done, and the strategy can be made for flood protection, or for dam making for multiple use.

The drainage basin area may be defined as the area which contributes water to a particular channel or set of channels. The delineation of sub basins in the
THE UPPER BETWA BASIN
(DRAINAGE ORDERS)

INDEX

FIRST ORDER STREAM
SECOND ORDER STREAM
THIRD ORDER STREAM
FOURTH ORDER STREAM
FIFTH ORDER STREAM
SIXTH ORDER STREAM

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Betwa catchment has been done on the basis of perennial streams marked on the toposheets. The measurements of morphometric analysis has been taken from the quarter inch topographical sheets.

First of all, the perimeter of the Betwa river basin has been demarcated. The whole river basin divided into sub basins, demarcating the perimeters of the basin of the major tributaries by marking of water divides. There are eight sub-basins in the Betwa river basin named after their trunk stream. Besh Bah, Halali, Bina, Sagar, Kethan, Konch. There are the sub basins formed by the tributaries of the main channel i.e. the Betwa river.

Stream number, stream lengths, spot heights, contour crenulation and area form the basic data for finding out various linear, areal and altitudinal aspects of the drainage basin. Stream order has been analysed here.

Stream order is a measure of the position of a stream in the hierarchy of tributaries (Leopald et al. 1964 p. 134). It offers a quantitative basis for comparison of the degree of development in the drainage nets having analogous size (Horton, 1945, p. 283). In the upper Betwa Basin, the Betwa river is the sixth order stream. The Besh, the Bah, the Bina and the Narayan streams are fifth order streams. The drainage order map of the upper Betwa basin, is showing first to sixth orders of drainage, each marked with characteristic legends.
Horton (1945) has also established a geometrical relationship of stream number with stream order. According to him the number of streams of different orders in a given drainage basin tend a close or nearly close an inverse geometric series whose first term is unity and the ratio in this series is termed as the bifurcation ratio. The bifurcation ratio is defined as slope of the line relating number of stream to stream order (Leopold et al. 1964, p. 138). Number of streams present in each order of the upper Betwa Basin and their mean bifurcation ratio have been calculated (Table 1.2) weighted means of bifurcation ratio have also been calculated (Table 1.3). The average bifurcation ratio is in conformation with the values calculated by earlier workers (mainly Horton 1945, p. 290; Strahler, 1957, p1 915) for different areas.

Table 1.2 Number of streams present in each order in the upper Betwa Basin.

<table>
<thead>
<tr>
<th>Stream order</th>
<th>No. of Streams present</th>
<th>Bifurcation ratio</th>
<th>Main Bifurcation ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>1590</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Second</td>
<td>361</td>
<td>4.40</td>
<td>-</td>
</tr>
<tr>
<td>Third</td>
<td>76</td>
<td>4.75</td>
<td>-</td>
</tr>
<tr>
<td>Fourth</td>
<td>17</td>
<td>4.47</td>
<td>4.49</td>
</tr>
<tr>
<td>Fifth</td>
<td>6</td>
<td>2.83</td>
<td>-</td>
</tr>
<tr>
<td>Sixth</td>
<td>1</td>
<td>6.00</td>
<td>-</td>
</tr>
</tbody>
</table>
An Evaluation of Geomorphometry and Geoenvironment of Upper Betwa Basin. Central India Olkoassay Vol.3 No.1
An Evaluation of Geomorphometry and Geoenvironment of Upper Betwa
Basin. Central India Olkoassay Vol.3 No.1
Table 1.3: Weight mean bifurcation ratio in the Upper Betwa Basin.

<table>
<thead>
<tr>
<th>Order of streams</th>
<th>No. of streams present</th>
<th>Bifurcation ratio</th>
<th>No. of streams involved in bifurcation</th>
<th>Products of column 3 and 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>1990</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Second</td>
<td>361</td>
<td>4.40</td>
<td>1951</td>
<td>8584.40</td>
</tr>
<tr>
<td>Third</td>
<td>76</td>
<td>4.75</td>
<td>437</td>
<td>2075.75</td>
</tr>
<tr>
<td>Fourth</td>
<td>17</td>
<td>4.75</td>
<td>93</td>
<td>425.71</td>
</tr>
<tr>
<td>Fifth</td>
<td>6</td>
<td>2.83</td>
<td>23</td>
<td>68.09</td>
</tr>
<tr>
<td>Sixth</td>
<td>1</td>
<td>6.00</td>
<td>7</td>
<td>42.00</td>
</tr>
</tbody>
</table>

Sum of products of column 5 = 11182.93

Total number of streams in 4 = 2511 column.

Weighted mean bifurcation = 11182.93/2511 = 4.453

The average length of streams present in each of the drainage order tend nearly close or close to direct geometric series (Horton, 1945, p.291). The relationship between the stream orders and the average length of the streams of each order has been given in Table 1.3. The ratio of average length of streams of any order to that of streams of the next lower order is known as the stream length ratio (n). According to Horton's estimates, the values of the stream length ratio should range between two
and three. The determined values of the stream length ratio of Upper Betwa Basin, though mostly are in the order of the calculations made by Horton, however, some of the values make departure from the normal path. Similar type of departure has also been noted by Satpathi (1981, pp. 131-132) while calculating values of stream length ratios of tributaries around sirckhum.

Drainage density is termed as length of stream channel per unit area and drainage frequency is termed as number of channels per unit area i.e. the drainage density and drainage frequency are measurements of the dissection of a watershed.

Table 1.4: Stream length (in miles) and stream length ratio in the Upper Betwa Basin.

<table>
<thead>
<tr>
<th>Stream order</th>
<th>Total number of streams</th>
<th>Mean of length of streams</th>
<th>Stream length ratio</th>
<th>Mean of stream length ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>3552</td>
<td>1590</td>
<td>2.23</td>
<td>-</td>
</tr>
<tr>
<td>Second</td>
<td>1189</td>
<td>361</td>
<td>3.29</td>
<td>1.47</td>
</tr>
<tr>
<td>Third</td>
<td>432</td>
<td>76</td>
<td>5.68</td>
<td>1.72</td>
</tr>
<tr>
<td>Fourth</td>
<td>186</td>
<td>17</td>
<td>10.94</td>
<td>1.92</td>
</tr>
<tr>
<td>Fifth</td>
<td>174</td>
<td>6</td>
<td>29.00</td>
<td>2.65</td>
</tr>
<tr>
<td>Sixth</td>
<td>86</td>
<td>1</td>
<td>86.00</td>
<td>2.96</td>
</tr>
</tbody>
</table>
The upper Betwa basin was divided into small unit areas. The values of length of streams present in each unit area as well as values of number of streams present in each area were placed on the map. The values were then contoured to get drainage density and drainage frequency maps (Fig. 3 and 4). The drainage density in Fig. 3 has been divided into four categories viz. less than two, two to four, four to six and six to eight. Drainage frequency in Fig. 4, has been divided into five categories viz. less than three, three to six, six to nine, nine to twelve and twelve to fifteen.

Both, drainage density and drainage frequency, depend upon the climate and physical characteristics of the watershed. The climate exerts important influence directly on the discharge of a river and indirectly on the erosion of a rock and/or soil and vegetation. The upper Betwa basin, however, is not a continental size, the climate can not be considered as common denominator over geology.

SOIL

Out of the long list of nature's gift to man writes Benette (1939,5) none is perhaps so utterly essential to human life as soil. Soil one of the three attributes of land is an outstanding renewable resources which sustains the biotic resources of vegetation and animal life.
That part of the upper dust of the earth from few cm, to several metres (maximum 3 metre) depth is called soil, which develops by mechanical or chemical weathering or by erosion process of different rocks and by the desintegration of living organisms and with the combination of different forms of elements of environment specially water and temperature. Thus it can be said that soil is actually formed as a result of long term process of complex interaction with interstitial organic matter living as well as dead. Modification of parent mineral matter is actually the result of interactions between climatic, topographic and biological effects.

Soil is one of the most important ecological factors. Plants depends for their nutrient water supply and anchorage upon the soil. These contributions of soil to plant is depend on its physical, chemical and biological characteristics. Among physical properties texture and structure are very important which determine such characteristics of soil as water absorbing and retentive capacity and movement of air and water chemical and biological properties determines its fertility status. All these rocks climatic conditions, relief, stage of development of the soil and biological influences. Infact, it is agriculture that modifies soils, excepting certain virgin soils which can retain their original characteristics on the whole soils constitute the physic base for any agricultural enterprise. Farming is a business and good
soil is the part of farmer's stock in trade. Good soils are good to the extent that man makes judicious use of them. Our standard of living which predominantly depends on agriculture is often determined by the soils and the crops and livestocks raised on them. Thus soils endowed with a proper combination of texture salts and human yield good result.

The amount of nutrients present in the soil determine the crop growth. The fertility of soil is contributed by the three nutrients namely, nitrogen, phosphorous and potassium. These must be studied in depth. Soil in villages, basins and on level plains are much deeper and attain a nature state than soils on slopes. Hence the former are of much greater fertility than of latter.

Out of these factors which determine the agriculture and vegetation forms, the soil is most important. The nature of soil also determines the types of grasses and forests in any region. Likely the agricultural land use regional distribution of crops, their productivity and quality are also determined by the soil nature. Hence in geographical distribution the analysis of soil is an essential part.

The systematic and detailed survey of soil has not been conducted in M.P. hence only broad outlines of its regional distribution is attempted. In the Bhopal, Vidisha plateau the soils can be classified in the
following types on the basis of their texture.

(i) Black soils.
(ii) Laterite soil.
(iii) Alluvium soil.

(i) Black Soils: The soil which deposited in the volcano regions, originated by the cracking of rocks in the ends of cretaceous period, is called black soil. There are different views about the colour of soil. According to vadia this black colour of soil is due to presence of iron, sitanium and biotic components, Oldham (1901) thought that the residual plants gives to the black colour to soil, white throbalt thought that this black colour of soil is due to the presence of only iron in the parent rocks.

The black soil occupies almost the whole plateau. It varies in depth and usually loamy to clayey in texture, lime concretion zone and free calcium carbonate are invariably present at different depth. Cracks develop in summer season and in deep clayey soil they are even a meter or more deep. This soil is usually ill supplied with phosphate, nitrogen and organic matter, but is sufficient in potash and lime and suitable for cotton, jowar wheat, sugarcane, groundnut.

So far as chemical composition of black cotton soil is concerned 84% soil indicate high percentage of potassium 54.5% are high in phosphorous, while 51% soils are low to medium in nitrogen, phosphoric acid and organic
matter but potash, lime and iron contents are usually high. The nitrogen content of regur soil is very low (0.02 to 0.05%) while phosphoric acid (0.08 to 0.15%) and lime (0.07-7%) also vary.

This soil has mainly three sub-types:

(i) Deep soil black.
(ii) Medium black soil, and
(iii) Shallow black soil.

But out of these three sub-types the deep black soil is not found in this plateau.

(ii) Medium black soil:

This sub-type occupies almost all the Shopal-Vidisha plateau. The soil of Sehore, Raisen, Vidisha, Shopal etc. is of this sub-type. In Vidisha, it has 30-35% clay. The depth of the soil is from 15 cm to 1 m. Thus these soil are not very deep but are suitable for most of the crops specially wheat, jowar and sugarcane.

The characteristics of these soils differ considerably from one place to another in this plateau controls mostly by the local topography and the underlying rocks. It is dark brown in colour, though patches of reddish and light brown are also found.

Shallow Black Soil:

This is found only in few places of the plateau in some parts of Lateri tehsil, Berasiya, northern part of Sehore tehsil, eastern part of the Ichhawar tehsil.
Raisen and Goharganj tehsil. This soils is of clay-loam type slopy land of hill region has not thick layer of soil because the matter which formed by the weathering of rocks has been eroded away by the water. Even the dense vegetation also can't check this quick dynamic process. Therefore, pure rocks are seen on the surface, while in plains and in villages of rivers the deposition of soil takes place and thick layer of soil is found. Rice, wheat and cotton alongwith millets are grown on them.