Jalgaon is one of the significant district in the state, famous for yellow metal and banana yellow gold. This district can easily be understood through three distinctive physiographic divisions.

1. Satpura upland
2. Piedmont plain

**Satpura upland** is largely covered with Deccan lavas and dotted by perennial springs. This region is characterized by faults, continuous escarpment, highly dissected surface, rapid flowing streams etc. The entire area is mostly covered with forest and dotted by perennial springs. Satpura range stretching east-west direction covering northern 30% area of Chopda, Yawal and Raver tehsils created obstacle to south-west monsoon winds, hence this region receive highest rainfall (>725 mm). Satpura upland is favorable for the construction of medium and minor irrigation projects, hence this region acts as storage of rain water and source of groundwater recharge which is beneficial to intensive banana and sugarcane belts thrives well in the piedmont plain.

**Piedmont plain** of the district comprises three tehsils namely Raver, Yawal and Chopda. It has an elevation of about 200 to 300 mts. It is a part of the district having lowest elevation characterized by alluvium deposition. The soils of this plain is not only in plant food but also reached at great depths. This physiographic region is monotonous flat plain from the foot of Satpura to Tapi river. Highest rainfall, alluvial soil and gentle slope became
favorable for perennial irrigated crops. Approximately 65% of banana and 35% of sugarcane cultivated area of the district is concentrated in this region. Both crops are perennial and require continuous and ample supply of water to irrigate the fields. It is found that high capacity electric motor pumps are installed on the wells indicating deep tube wells and ample groundwater storage. Raver tehsil is famous for intensive banana belt while in Yawal tehsil both sugarcane and banana concentration is found. Highest concentration of sugarcane is found in Chopda tehsil. This region has lowest density of wells. Depth of wells is more than 300 to 400 feet. Area under per well is more there. It is also experienced that high capacity motor pumps (>7.5 HP) are installed on all wells. It is concluded that in piedmont plain banana and sugarcane crops are concentrated only because of acute storage of groundwater. To enrich groundwater storage following ideal geographic conditions is responsible:

- Abhora, Mangrul and Suki water projects are constructed in Satpura upland area. These projects are recharging groundwater from north to south direction in piedmont plain where intensive banana belt is existed.

- Hatnoor major water project constructed across the Tapi river is also recharging groundwater from south to north direction (Map No 6.4). Therefore intensive banana cultivation is concentrated along the both sides of Suki river. This is only one example found the district which is recharging original deep groundwater.

**Khandesh Upland** comprises Girna- Bori basin, Vaghur- Bhogavati basin, Purna basin, Jalgaon Jamner plateau and Chalisgaon plateau, covering southern part of the district.
This region comprises 12 tehsils located in the south of Tapi river. Girna, Waghur, Purna and Bori river basins are found favorable for irrigated crops. This region receives 700 to 725 mm rainfall. Along the both sides of these rivers, deep black soil is observed. Remaining whole area is characterized by medium black soil. Southern part of the study region is interrupted by small hills, undulated area, broad basins deposited with alluvium and in some areas, basalt rocks are exposed. In this region crop diversification index is found high. Perennial irrigated crops are observed in small pockets. Generally farmers are irrigating the land for seasonal crops such as Cotton, Jowar, Corn, Wheat and Vegetables. This region has highest density of wells. More or less all wells have low capacity motor pumps (<5 HP motor pumps). High density of wells, low capacity HP pumps and seasonal irrigated crops indicate that groundwater supply is not sufficient. Therefore farmers are attempting to dig out new additional wells to irrigate their fields. Hence density of wells is more there.

Government has constructed large number of medium water projects to irrigate the land as well as to recharge the groundwater. It is found that Manyad, Jamda, Agnavati, Hivra, Bahula and Bhokarbari medium water projects constructed across the Girna river and its tributaries are recharging subsoil groundwater, however, the rate of recharging is low. The depth of recharging is found only up to the 50 feet deep from the surface. Therefore most of the farmers prefer to cultivate seasonal irrigated crops because of insufficient supply of water in the wells. These crops require supplementary irrigation for only 3 to 4 months of the year.

It is concluded that the southern part of the study region has shortage of groundwater. Hence farmers are cultivating seasonal irrigated crops
instead of sugarcane and banana crops. After the analysis of data collected from MSEB office, it is found that out of the total motor connections of district about 21.50% connections are 3 HP, concentrated in Chalisgaon, Bhadgaon and Pachora tehsils. In these tehsils irrigated area under per well is found 3 to 4 ha. It is clear that farmers could not get sufficient water to irrigate the fields.

It is concluded that more number of wells, low capacity of wells to irrigate the fields, low HP motor pumps and seasonal irrigated crops indicating that southern part of the region has scarcity of groundwater while northern part of the region is enriching with banana and sugarcane cash crops only because of ample supply of groundwater and favorable eidiaphic condition. To find out causes behind such imbalance physical and economic conditions, command area of Jamda water project is selected for sample study.

Chapter No 7 is devoted for a case study of groundwater levels in the command area of Jamda irrigation project. Command area of Jamda water project is bounded by 20° 30’ N and 25° 45’ N latitudes and 75° 0’ E and 75° 15’ E longitudes, covering 539.2472 sq km of land (53924.72 ha). An average elevation of the watershed is 712 m above MSL, slopping towards east. Both north and south border lands of the watershed are occupied by high lands. The middle entire watershed is plain with well fertile alluvial soil deposited on basaltic structure. Annual average rainfall is 652.79 mm and maximum and minimum temperature of the region is ranging between 40.7 and 25.8 °C.

The area selected for case study comprises 84 villages. In the sample study area Maharashtra State Electricity Board has provided electric
connections to 11795 wells. It is observed that out of total wells about 71.03% wells have provided 3 HP electric loads to motor pumps. There are 2789 wells (23.65%) those have 5 HP electric loads. It is clear that most of the farmers are using 3 HP to 5 HP motor pumps, indicating shallow depth of groundwater.

Out of 84 villages located in micro watershed area about 41 villages are selected for the detailed study of seasonal fluctuation groundwater and recharging effect of water projects. From each village approximately 10 farmers are selected for personal interview. Thus researcher has approached to 410 farmers. During the sample survey it is found that in the study region depth of basalt rock is found 10 to 30 meters from the surface varying from place to place, controlling the groundwater recharge. Map No 7.6 reveals that in the central part of the watershed located along both sides of river Girna, intensity of wells is found very high and depth of rock is found more than 20 meters.

Maps showing total irrigated area, depth of rocks and spatial distribution of irrigated crops are superimposed on each other and concluding remarks are drawn cited as below.

- Left bank canal is recharging a well that’s why more number of wells is found there.
- In the southern part of the region right bank canal is weak to recharge the wells and groundwater.
- Village Wade is located between Girna and right bank canal, having 350 wells. Reaming all villages located along the right bank canal has five wells
hence scattered distribution of wells is observed along the both sides of right bank canal, indicating low recharging rate of groundwater.

- It is observed that more or less all farmers have constructed wells in their small fields; hence density of wells is more. High density of wells and small irrigated field indicating that capacity of wells to irrigate the fields is low. On other hand utilization of groundwater is more. During the survey all farmers have reported that they are suffering from insufficient supply of groundwater to irrigate their fields.

To correlate the HP wise motor pumps and depth of groundwater level, maps showing spatial distribution of 3 and 5 HP motor pumps are prepared separately. Map showing wells installed with 3 HP connection clears that the area covered by high intensity of wells is very small (0.67%), There are two zones found with high intensity. One zone is located near the Jamda dam and another is found the east. Remaining 90.63% area has low intensity of wells installed with 3 HP pumps. This map reveals that except two small pockets, remaining 90.63% area has insufficient recharge of groundwater.

Spatial distribution of 5 HP motor pumps clears that in the study region medium to high concentration of 5 HP motor pumps is found the eastern part of the study region where ground water is comparatively deep than the western part. Gusardi kh, Bornar, Bodarde, Savade and Bhadgaon villages are included in high intensity zone. This belt is located in between Girna river and left bank canal. It is obvious to note that in the eastern half of study region, depth of groundwater is 30 to 45 meters. While in the west, 3 HP motor pumps installed on wells are more, indicating that the depth of groundwater is about 16 to 20 meters.
Maximum capacity of 3 HP motor pumps to lift the water from the wells is about 18 meters and in case of 5 HP pumps it is about 35 meters. With the help of capacity of HP motor pumps groundwater contours are drawn. Groundwater contour map reveals that highest depth of groundwater level is observed in the central west part of the study region which is about 5 km east of Jamda dam. This is the area where depth of rock is found more than 20 meters. Farmers of this region have attempted to dig out their wells up to the level of rock sheet. It is also discernible to note that in the same area pre monsoon groundwater level is found more than 20 meters. It is clear that rock sheet beneath the surface have controlled the depth of groundwater. This type of condition is observed in the Bahal, Gudhe, Navare, Wade etc villages.

Map showing spatial distribution of depth of rocks clears that along the northern boundary of study area depth of rock beneath the surface is found <10 meters, while near the bank of river Girna it is more than 20 meters. It is clear that dip of rock is found from north to south direction. Large number of percolation tanks is constructed near the northern boundary. They are recharging wells located in between high land and Girna river, because of north south dip of rock sheet.

Chapter No 8 display seasonal fluctuation of groundwater level in the study region. Fluctuations of groundwater have a direct bearing on irrigated crops. Farmers prefer seasonal irrigated crops where groundwater fluctuation is more. Low fluctuation or stable groundwater helps to exist perennial irrigated crops. From this study it is concluded that most of the area has shallow depth of groundwater level.
During pre monsoon period it is observed that in central part of the region there is a small pocket of high fluctuation of groundwater level having depth of groundwater level more than 20 m. This pocket has covered an area of 2.49 km\(^2\). This is an area where rock beneath the surface is found more than 20 m deep. It is clear that depth of rock sheet is responsible to control the groundwater level. In this pocket area of village Naware is included. This village is located near the bank of Girna river. Second outer area of above pocket has covered 34.33 km\(^2\), where depth of groundwater level is found 15 to 20 m from the surface. This pocket is found in between left and right bank canals. In this pocket eastern part of Bahal, northern part of Wade and southern part of Gudhe villages are included. Most of the surveyed farmers have reported that during summer season their wells remain dry. Hence they are unable to cultivate perennial irrigated crops.

Post monsoon is the period of groundwater recharge. This is a significant period of intensive irrigation. In the study region farmers prefer to cultivate wheat, yellow gram, and groundnut. These crops require 5 to 8 frequency of irrigation. If groundwater recharge is weak, it directly affects on crop production. During survey it is noticed that farmers have obtained average production. It is clear that up to the month of January groundwater level is stable but after the month of January temperature start to increase. Water requirement of crops is also increase. Hence farmers do not dear to cultivate perennial crops such as sugarcane and banana only because of shortage of groundwater. It is clear that during the four months i.e. November to January, dam, canal and
percolation tanks are recharging the wells. In the months of April and May most of the wells sucked up and remain dry.

Fluctuation of groundwater depends upon various geographical as well as social factors. Geographical factors such as types of soil, proportion of sand, clay and silt, slope of surface, land coverage, depth and types of rocks. Social factors such as extraction of groundwater, types of cropping pattern, knowledge of irrigation system and rational use etc are important. Fluctuation in the groundwater is an indicator of economic condition of farmers. For example in Raver tehsil of Jalgaon district about 90% farmers are growing banana continuously since 6 to 7 decade, it is only because of stable and ample groundwater supply. In the present chapter an attempt is made to calculate groundwater fluctuation in the study region. To find out the different classes of groundwater fluctuation mean, standard deviation and Co-efficient of Variation technique is used. Table No 8.2 clears that out of 41 villages about 24.39% villages have low fluctuations in the groundwater level. Average fluctuation is observed in 24.39 % villages. High fluctuation is found in 51.22% villages. It is clear that more than 50% villages are facing the problems of high fluctuation of groundwater level. Map No 8.3 is showing spatial distribution of CV reveals that low fluctuation (<10%) is found in small pocket located on 20° 37’ 40” N and 75° 5’ 40” East Longitude, in between left bank canal and Girna river. In this area where depth of rock is more, depth of groundwater level during pre and post monsoon period is more with low fluctuation. It is clear that depth of rock is positively responsible for low fluctuation. Naware and southern part of Gudhe villages have high potential and stable groundwater. This map also clears
that groundwater fluctuation is increasing towards all direction from the high potential zone. Very high fluctuation more than 35% is observed along the northern, southern, eastern and western boundary of study region. It is also observed that near the dam site fluctuation is found 25% to 35%. It is concluded that Jamda dam is not significantly recharging groundwater level.

Remarks:

• Percolation tanks are constructed, but out of them very few tanks are recharging subsoil groundwater.

• Jamda dam is filled up with silt deposition. Therefore storage capacity of water in the dam is insignificant. However this dam is recharging the area up to 8 km towards the east, along both sides of Girna river.

• Left bank canal is capable to recharge ribbon shape area along both sides of canal. But due to sit deposition in the dam, mostly canal remains dry.

• Though Girna is perennial river, result of recharging its water is absent due to rock sheet exposed on the bed.

SUGGESTIONS:

Here a try has been made to suggest planning for the enhancement groundwater recharge and to increase area under perennial irrigated crops. This planning requires little capital.

• In Jalgaon district more number of barrages should be constructed across the Tapi and Girna rivers to get more benefits.

• Considering the intensity of Banana and Sugarcane in piedmont plain seepage canal should be constructed parallel to the Satpura foot. All rivers originated from the Satpura upland should be linked to each other on the
plain. Such linking of rivers will be more beneficial to the farmers those are irrigating the land for banana and sugarcane.

- In Yawal tehsil extensively area has also original groundwater storage. At present both sugarcane and banana crops are dominant here. If this zone is protected by applying drip irrigation system this area will serve for a long time.

- Government has declared various schemes of drip and sprinkle to motivate the farmers. But such types of subsidies are sanctioned to the farmers those have cultivated specific crops such as banana and fruits. If such ban is removed, obviously, all farmers will apply drip irrigation system. At least relaxation should be given to the farmers those are interested to cultivate sugarcane, cotton and onion crops.

- It is suggested that in the Jamda left bank canal line, small barrages having the height of 5 feet with 3 km internal should be constructed to store the water.

- During rainy season about 50% discharge of flooded river should be diverted in the canal. Surveyed farmers have reported that when canal flowed out, their wells recharged up to two months. If government thinks to consider the plan suggested by researcher about 192.64sq.km. hectare of land will be irrigated for perennial crops.

- All percolation tanks are filled up with silt deposition. Necessary action should be taken or permission should be given to the farmers.

- Irrigation capacity of wells is found very low, subsoil groundwater is insufficient, density of wells is high, hence to get sufficient supply of water
all farmers are digging additional wells in their small fields. It is requested to government that additional wells should be banned.

It is concluded that geographic condition of a study region is most favorable for banana and sugarcane cultivation; however, due to economic craving nature of farmers and little attempts to recharge groundwater, farmers are facing lot of problems related to storage of groundwater. If farmers, government agencies and planners attempt to enhance recharging rate of groundwater with decreasing rate of utilization by considering crop management, obviously economic condition of study region will be developed. Thus hypothesis is tested positively