CHAPTER – 1

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1.1 History of Agrobase industries in Maharashtra:

The industrial history of Maharashtra state can be traced back to the last quarter of the 19th century. In the beginning, Bombay continued to be an industrial center for the growth of textile industry. This industrial growth has, however, played a very important role in spreading an industrial culture in the hinterland of the state (Sabade, 1990). This has further led to an emergence of many agro base industries like Sugarcane, Distilleries, Paper and Pulp, etc in the rural part of the state. However, amongst these, sugar industries with its allied units have become largest national industries next to textile industries.

The agro base industries in the Maharashtra hold key position in governing economy, education, politics and social activities for the rural population and have been able to change the socioeconomiccal face of rural area within their territory.

Before industrial revolution in the country as well as in the state, the agro base industries, especially sugar and its allied units were located only in Bombay and other major district places of the state like Pune, Kolhapur, Ahmednagar, Sangali etc and were owned by private sectors. However, after 1950 the cooperative movement in agro base sector has played important role in rural development of the state. The cooperative sector therefore, has provided the foundation for the sugar
cooperative movement in the state as well as in country. Since then, Sugar industry became the largest agro-based industry located in the most part of the rural India. About 45 million sugarcane farmers, their dependents and a large mass of agricultural labourer are involved in sugarcane cultivation, harvesting and ancillary activities. Beside this, about 0.5 million of skilled and semi-skilled workers, mostly from the rural areas are engaged in the sugar production. The sugar industry in India has been a focal point for socio-economic development in the rural areas by mobilizing rural resources, generating employment and higher income, transport and communication facilities. Further, many sugar factories have established schools, colleges, medical centers and hospitals for the benefit of the rural population. Some of the sugar factories have also diversified into byproduct based industries and have invested and put up distilleries, organic chemical plants, paper and board factories and cogeneration plants. The industry generates its own replenishable biomass and uses it as fuel without depending on fossil fuel. Now days there are an enormous contribution of sugar industries to Indian economy (Agarwal, 1987).

There are 553 installed sugar mills in the country with a production capacity of 180 lakh MTs of sugar. These mills are located in 18 states of the country. About 60% of these mills are in the cooperative sector, 35% in the private sector and rest in the public sector. There are 1750 agro base industries in the country, out of which 553 contributes a lion share as sugar industries. Maharashtra is one of the leading state having 183 Sugar industries owned by private and cooperative sectors (Senthikumar, 2001).
The constant willingness of politician and government for setting up of more and more sugar industries in all parts of the state is an indication of its pertinence to the general economic prosperity and rural development (Anand, 1987). Inspite of the fact that the sugar industry is backbone of rural economy of Maharashtra, subsequently a need has been arisen to review and take cognizance of other associated environmental problems with it. However, it should be noted that the geometric increase in sugar industrialization along with high rate of urbanization and subsequent increase in population has led to unpredicted increase in the environmental degradation of the natural resources. The enormous quantities of waste generated and released by these rural industries have created the problems of water, air and soil pollution.

1.2 Water:

All the living beings on the earth can survive without food for couple of hours or days, but will not survive without water resource for couple of hours or days. Even water consist of an exceptional quality of dissolving a number of substances without changing their chemical nature and therefore play an important role in transporting material not only in the living body but also in the nature. Hence, water has got unique importance amongst the natural resources. Clean water is one of the most valuable and under appreciated resource of our planet. Approximately 70 percent of the earth's surface is covered with water, but only a small fraction of this water is fresh water that is actually available for consumption and productive use. Because of the unique properties of water, a dynamic cycle, known as the Hydrological Cycle,
has developed on this planet. This cycle provides for the continuous movement, transformation, and remediation of water as it moves through a series of solid, liquid, and vapor phases (Berner and Berner, 1987).

The hydrologic cycle describes the constant movement of water above, on, and below the earth's surface. As part of this cycle, water is transformed between liquid, solid and gases states. Condensation, evaporation and freezing of water occur in the cycle in response to the earth's climatic conditions (Berner and Berner, 1987). The hydrologic cycle begins with water evaporation from the earth's soil, plant and water surfaces to form water vapor. The sun supplies the energy required to evaporate water. The vast majority of evaporation occurs from the oceans. It is estimated that 39 inches of water annually evaporate from each acre of ocean. Water vapor is drawn into the atmosphere by temperature gradients and can be transported over hundreds of miles by large air masses. When water vapor cools, it condenses to form clouds. As water condenses within clouds, water droplets increase in size until they fall to the earth's surface as precipitation such as rainfall, hail, sleet or snow. It is widely distributed over the surface of the earth, occurring in the form of oceans, rivers, lakes, springs and streams. In addition there is groundwater too, which occurs under the surface of the earth. Approximately 50 to 90 percent of the water that falls to the earth's surface enters the soil. This water can become groundwater but most of it evaporates from the soil surface, used by vegetation via evapotranspiration, or flows to streams and springs as interflow. Water that passes through the root zone may continue to move downward to reach the groundwater. In soils with fragipans, clay pans or other low permeable strata of a limited extent,
this water may create a seasonal high or perched water table. The distance water has to travel to reach groundwater can range from a few feet to hundreds of feet. Water movement toward groundwater may take hours or years, depending on the depth to the aquifer and the characteristics of the unsaturated zone (Krupanidhi, 1984).

The groundwater, move slowly to discharge points i.e. from high water surface elevations (high pressure or head) to low water surface elevations (low pressure or head). In general, the water flows more rapidly where large differences exist in water surface elevations (steep hydraulic gradients), but this is not always the case. A large variation in the hydraulic gradient could also mean a lower permeability formation. Groundwater may move toward or away from streams or lakes, depending on the hydraulic gradient. As it moves it may be removed by a pumping well, or it may be discharged to the earth's surface, which may include: springs, streams, lakes, wetlands, or even the ocean. It enters slowly within the groundwater aquifer, often remaining in storage for 100s of years. It is stored in the voids, spaces and cracks between particles of soil, sand, gravel, rock or other materials. These cracks or space can include fractures, faults, bedding planes, solution channels (limestone formations), dissolution channels associated with more easily weathered material or other structural features such as bed planes or deformation in the bedrock due to folding. These materials form what is sometimes called the groundwater aquifer or reservoir. In most areas of the world water does not flow in and is not stored in large underground lakes or rivers. The only exception to this might be the dissolution channels and caverns
associated with limestone formations and mine shafts associated with underground mining operations.

The volume of groundwater is much greater than that of all fresh water combined. Under ground water therefore play an important role in the overall water balance of the environment. As a reservoir has a enormous capacity to store water in rainy period which can be utilized during dry period. Therefore it stands a primary source of fresh water in several towns and in rural areas. The existing utilization of groundwater in India is currently estimated to 45000 million M$^3$. Even it is widely used as source of water for irrigation and other farm use. The contribution of groundwater to the total irrigation is about 40% in India (Goel, 1997).

Of the total volume of water in the hydrosphere, approximately 97% is in the gigantic oceans which is not useful for our daily requirement because of its high salt contents (Drever, 1982) The remaining 2% of water in the hydrosphere is locked at the polar region in the form of ice sheets, and 1% is available as a fresh water occurring in the form of rivers, lakes, streams and groundwater which can be used for our daily consumption, provided its quality is wholesome (Mahida, 1981; De, 1986; Goel, 1997). Amongst this ground water is a primary source of fresh water in several towns and rural areas.

As long as human population was small and communities were scattered over large area of land, the disposal of domestic waste creates no problems. But as communities were become more concentrated and villages and towns grew, the disposal of waste created new problems. Perhaps this was origin of problem of water pollution and became a serious menace to public health. This problem becomes more
complicated in arid and semiarid areas where scares and unevenly distributed water sources are available. Under this condition the polluted water are not sufficiently diluted with rainwater even in rainy period. With expanding industrial activities at most places discharging their waste in neighboring stream, the later got more polluted and progressively unsuitable as a source of potable water. Such stream also becomes unfit as a source for irrigation and for other use in some areas (Deshmukh, 1964; Ghosh, 1992). Very often putrifying solids are deposited along their channel and sides, producing obnoxious odor and public nuisance. In many industrial areas streams are much polluted that they are becoming progressively unsuitable as a source of water supply for any other purpose.

1.2.1 Groundwater:

The term ‘Ground Water and its Quality’ covers a widespread meaning and referred by an individual depending on the suitability of ground water for intended use. The ground water quality is indicated by the amount of dissolved or suspended inorganic or organic material in ground water by means of which it acquire physical and chemical characteristic. Under natural condition, the composition of ground water depends on the composition of rainwater, soil strata and aquifer material and changes with time and space (Karanth, 1989). With rapid development in urbanization, industrialization and agricultural and mining activities, the ground water contamination with hazardous waste and wastewater is becoming a common phenomenon (Pawar, 1985). This has brought undesirable change in ground water quality. The water quality and human health are closely related. The use of such
contaminated water for drinking purpose may cause an adverse impact on human health (Colmy, 1987). The determination of the physical, chemical and bacteriological quality of ground water is becoming essential to evaluate water quality (Dasgupta and Purohit, 2001) for different purpose as per water standards drinking, irrigation, industrial etc. laid down by different standard institutions (WHO, 1971; USEPA, 1975; ISI, 1983).

The central groundwater board, Nagpur is carrying out the ground water quality monitoring in Maharashtra and Union Territory of Dadra and Nagar Haveli for the last three decades to assess the trend in the ground water quality and its suitability for the different purposes. The regional chemical laboratory of the Board at Nagpur is playing a great role in the process of ground water quality monitoring.

1.2.2 Groundwater quality of Maharashtra:

The ground water quality monitoring carried out by the central groundwater board in Maharashtra State and at Dadra and Nagar Haveli in the year 2002 through its established network stations indicated that the ground water quality is good in major part of the state and union territory. The ground water is mostly dominated by the alkaline earth-weak acid (Ca-HCO₃), type of water in majority part of the state and union territory. The total dissolved solids in 57.6% of ground water samples collected during ground water monitoring was below desirable limit (500 mg/L) of BIS drinking water standards indicating that the ground water in the state is suitable for drinking purpose. The SAR value of 98.7% of samples was found between 0-10, which shows that the water is good for irrigation purpose. However, classification of the
samples as per salinity and sodium hazard shows that 35.7% and 50.3% of ground water samples falls in medium salinity and low sodium water and high salinity and low sodium water respectively.

Although, the results of ground water quality monitoring study and specific studies carried out by the board have shown that the ground water quality in some urban and industrial pocket of Maharashtra is undergoing deterioration, especially in the areas where chemical and sugar industries are located. The concentration of few toxic ions and load of organic matter in ground water in the vicinity of these industries are increasing. The contamination of ground water with nitrate due to lack of proper sanitation facilities, disposal of domestic waste and sewage in unlined channels and agricultural activities in rural and urban parts of the state is becoming a common phenomenon. The natural contamination of ground water with fluoride in Yavatmal, Chandrapur, Bhandara, Nanded, Osmanabad and Nagpur district is also becoming common. The inland salinity problem in Purna basin of Amravati, Akola and Buldhana districts is making ground water management difficult (CGB, 2004)

1.2.3 Groundwater contamination:

The contamination of ground water from the manmade and natural sources is causing a great threat to the ground water system. The increase in urbanization and industrialization are generating huge quantity of waste and wastewater. The disposal of these waste and wastewater without proper treatment on unlined surface is finding its way to groundwater through percolation. The increase in use of chemical fertilizers, insecticide and pesticide in agricultural field has
also contaminated the ground water (Handa, 1981; Millani and Kour, 1999). In coastal area, the increase in demand of water has led to excessive abstraction of ground water due to which the problems like sea water intrusion is arising. The excessive abstraction of ground water and dewatering in mining areas has also caused changes in geochemical environment leading to appearance of hazardous metals like arsenic in ground water. The contamination of groundwater due to release of elements like fluoride from its naturally occurring minerals is also becoming a cause of concern. The absence of regular recharging of ground water and increase in evopo-transportation rate under natural condition has given rise to inland salinity problems. These contaminations of ground water from anthropogenic and natural sources have led to bring the undesirable change in the physical, chemical and bacteriological quality of ground water making it unsuitable for the drinking, irrigation and industrial use (Kulkarni, 1990).

The central ground water board; Nagpur has undertaken specific ground water pollution studies in different parts of Maharashtra to study the impact of natural and manmade activities on the ground water quality. The outcomes of these studies are summarized with few cases of groundwater contamination in Ahemednagar district due to sugar industry and its allied units in rural part. To get the severity of water pollution in rural part a study around Distillery and Paper unit of Sangammer Bhag Sahakari Sakhar Karkhana and Mangalam industries located near Sangamner city in Ahmednagar district of Maharashtra has brought out the facts that the damage to the ground water in the areas is due to the percolation of the effluent generated from these industries.
The water samples were collected from dug wells, bore wells and effluent storages. The depth of the ground water level varied from 3.4 to 30.0 mts. The analysis of the background sample indicated CaHCO$_3$ type, which is typical of basalt origin. The ground water near storage of spent wash from distillery has total dissolved solids (TDS), Cl, and SO$_4$ and chemical oxygen demand (COD) ranging between 4430-4615, 2213-2369, 354-366 and 520-684 mg/l respectively with dark brown color and unpleasant smell. The irrigation practice with spent wash having high TDS, Cl and SO$_4$ content from paper unit was causing damage to ground water. The ground water quality around Mangalam industry has also been affected with conductivity ranging between 11000 to 54000 mS/cm at 25°C and TDS, 4800-20000 mg/L with very high concentrations of cations and anions. The BOD and COD have gone as high as 450 and 1678 mg/l respectively. The quality of ground water around SBSSK and Mangalam industries clearly indicates that heavy percolation have taken place from these industries. The CaHCO$_3$ type of ground water has changed to CaCl$_2$ type with color and odor of most of the samples aesthetically unfit for drinking purposes. TDS, TH, Ca, Mg, Cl and NO$_3$ content are above maximum permissible limit of BIS for drinking water in 50% of samples. Thus this case has proved that the agobase industries were responsible for the contamination of groundwater both biologically and chemically in rural part of Maharashtra by deteriorating the quality of water for different purpose. This also indicate that how problems are worsening in the rural part. The second case study carried out by pollution board was at Chitali distillery located Chitali village in the Godavari river basin and falls under the semi-arid region and rain shadow zone of Maharashtra. It is
having almost flat topography with gentle slope towards northeast and
is underlain by basaltic lava trap. The distillery is involved in the
production of industrial alcohol, extra neutral alcohol, country liquor
and Indian made foreign liquor. The total water consumption of
distillery for industrial use was 880 m³/day and the industrial effluent
i.e. spent wash generated was 750 m³/day. The industry did not have
the full-fledged effluent treatment plant facility before 1996 and was
storing the spent wash in the unlined lagoons, which was spread in 32.8
hq. area and located upstream of village Chitali. The ground water
quality deterioration in the area is mainly caused by the percolation of
the spent wash from the unlined lagoon to spent wash. The hydro
geological investigations have revealed that the basaltic lava flow
(Deccan Trap) is the main water bearing formation in the area. Ground
water in this formation occurs under phreatic condition in shallow
aquifers and semi confined to confined condition in deeper aquifers.
The depth to water level in these wells ranges from 6.30 to 15.30 mts
The depth of water level in and around distillery which is located
slightly higher elevation have comparatively shallow water level
ranging between 6 to 9 mts. while the area around village Chitali and
near to lagoon ponds have deeper water level ranging between 9 to 12
mts. In few patches, water level was more than 12 mts have also
encountered. The untreated spent wash sample from distillery had
shown that it was having a dark brown color with unpleasant smell
coupled with high organic and inorganic content as indicated by the
COD value (153560 mg/l) and the concentration of the ions like Ca
(2800 mg/l), Mg (1215 mg/l), Na (9200 mg/l), Cl (8165 mg/l) and SO₄
(4516 mg/l). The high concentration of metals like Fe (65 mg/l), Mn
(17.64 mg/l), Zn (30.58 mg/l), Cu (1.63 mg/l) and Cd (0.61 mg/l) also noted. The spent wash after primary and secondary treatment indicate that total dissolved solids, total hardness, chemical oxygen demand and ionic content of the spent wash has come down after the treatment retaining dark brown color and unpleasant odor with pH on alkaline side. The spent wash stored in unlined lagoons after treatment was also having dark brown color and unpleasant smell with pH on alkaline side. The TDS and TH were found to be 30140 and 6000 mg/L respectively with COD 38957 mg/l. The concentration of Ca, Mg, Na, Cl and SO₄ were found 2200, 121, 9315, 8520 and 2356 mg/l respectively. The evaporation has caused to increase the concentration of the different parameters in the spent wash stored in the lagoon pond. These results of spent wash, which was stored in the unlined lagoons after treatment, indicated that these parameters are still quit high and are causing severe damage to the ground water quality. The ground water results from dug wells located nearby and on downstream side of the unlined lagoons where spent wash was stored had shown that ground water has undergone undesirable changes in physical and chemical characteristics, due to percolation of spent wash into the ground water. The ground water, which was free from color and odor and with TDS of 479 mg/l as shown by the analysis of background sample, had become brownish in color with unpleasant smell while the average TDS of the ground water has increased 7 times. The concentration of ions like Ca, Mg, Na, Cl and SO₄ in the ground water had increased as high as 1242, 1968, 595, 7674, 1909 mg/L respectively. The COD of the ground water as high as 714 mg/l has clearly shown the extent of pollution in the area. The presence of metals like Fe and Mn in a
significant amount had also increased the severity of pollution in the area. The comparison of the ions concentrations, ionic ratio, in background sample with the ground water samples collected from the downstream and in the vicinity of unlined lagoons where spent wash was stored had shown a tremendous change after pollution. The concentration of ions like Ca, Mg, Na, Cl, SO$_4$ in background sample was 56, 49, 46, 85 and 108 mg/L respectively and after pollution the concentration of these ions in ground water of the area had shown average increase of 473, 335, 194, 1395 and 885 mg/l respectively. The ground water, which was of Ca-HCO$_3$ type representing ground water in basaltic terrain, had also changed to Ca-Cl$_2$ type after pollution. The impact of percolation of spent wash to ground water in the immediate vicinity and downstream area of unlined lagoons on ground water quality is more prominent. The use of such polluted ground water and of spent wash for the irrigation purpose has helped to spread the pollution. The color and odor of ground water observed in some part of the study area has aesthetically made ground water in the area unfit for the drinking water purpose. Besides the concentrations of various parameters like TDS, TH, Ca, Mg, SO$_4$, Cl and NO$_3$ have affected the potability of ground water to a larger extent as it has crossed the maximum permissible limit of BIS for drinking water in the majority of samples. The concentration of metals like Fe and Mn in few samples was also above the maximum permissible limit of BIS for drinking water making water unfit for the drinking purpose. The ground water in the area has also become unsuitable for the irrigation purpose as the electrical conductivity values of the majority samples falls in very high salinity zone (Kulkarni, 1990).
In the past, many studies (Gupta, 1969; Manas, 1976; Kundra and Purthi, 1979; Handa, 1981; Krupanidhi, 1984; Pawar, 1985, 1987; Bhargava, 1985; Tiwari and Ali, 1988; Sinha, 1991; Panda and Das, 1993;; Narian and Chavan, 2000; Patil and Tijare, 2001) have been reported that water bodies are getting contaminated increasingly due to domestic as well as industrial waste waters in many parts of our country. In addition, in rural areas much community wells and bore wells are dug in the close vicinity of human localities or close to public places, to overcome the domestic water scarcity problems. At such places number of activities such as washing of cloths, household utensils, lorries, animals and taking bath etc. are exercised regularly. As there is no proper sanitation system, the used water gives rise to a stagnant water pond, which in turns acts as biological culture and media for number of organism. As a result the organic and inorganic matter is mixed in the water in large amount. Due to the presence of the nutrients like NO$_3^-$, PO$_4^{3-}$, Na$^+$, K$^+$ etc. these organism starts growing there, which helps in decrease in oxygen contents of the water and developing anaerobic condition. Therefore, the worms carrying diseases grow luxuriantly in such polluted water resulting in diseases like cholera, typhoid, diarrhea, hepatitis, and bacillary amoebic dysenteries.

Industrial and domestic wastewater comes in contact with natural water bodies. Such waters contain large amount of dissolved chemical constituents. In rural areas industries like dairy Poultry Paper and pulp Distilleries and Sugar industries releases the waste water after partial or without any treatment on the land surface or directly in to natural water bodies thereby admitting some hazardous chemicals and chemical
minerals like Ca$^{2+}$, Mg$^+$, NO$_3^-$, PO$_{4}^{3-}$, Na$^+$, K$^+$ etc. get in ground water by percolation through sub soil and thus contaminate the groundwater (Bharti and Krishnamurthy, 1990; Kross, et.al., 1993; Payne, 1993; Goel, 1997; Bhanja and Ajoy, 2000; Dasgupta and Purohit, 2001; Jameel, 2002; Mary Esther and Rana Kauser, 2004). Disposal of wastewater from industries in open space and abandoned dug wells have thus caused the pollution of groundwater in some rural part (Chaterji et.al, 1964; Vishwnathiah et.al, 1977; Ubale et.al, 2000; Wagh et.al, 2000; Shakhare et.al, 2005). This effluent often infiltrate up to the phreatic zone of aquifer depending upon the porosity and permeability of the medium resulting in unacceptable concentration of total dissolved solids, fluorides, iron, Chemical oxygen demand, biological oxygen demand, sodium resulting in sever contamination of groundwater.

The use of such contaminated water having high salts content for irrigation may deteriorate the quality of soil and can give rise soil pollution.

1.3 Soil:

Soil may be defined as a thin layer of earth crust, which serves as a natural medium for the growth of the plants. The arrangement of soil particles gives different shape to it viz. platy-horizontal alignment, prism like-columnar type, block like-angular or sub-angular types, spirodial-granular and crumb types. These particles give different size i.e. texture to the soil and hence it is one of the important property of soil, since it influences aeration, permeability and water capacity (Daji, 1985). The varying proportions of particles of different size groups in a
soil are known as soil texture (FitzPatric, 1983). The principle textural classes are clay, clay loam, sandy clay, silt clay, sandy clay loam, silty clay loam, sandy loam, silt loam, sand, loamy sand and silt (USDA, 1954).

As fertility and productivity of crops are depends mostly on texture it has immense importance in agriculture. Because the soil is one of the most precious resource of the earth, forming a carpet of variable thickness on the land, it has sustained a succession of the life and civilization, providing food, fuel and fiber, strong life giving water and supporting shelters and dwelling, structure that man build. Soil is integrally and immediately connected with the rock beneath the vegetation growing above and the water percolating through it. Soil consist of product of weathering rock, intermixed with living organism and the product of their decay, the moisture and air filling the interstitial space. It thus has a microclimate of its own controlled water, air and organism (Mahida, 1987). The silt particle contributes the framework and the clay (montmorillorite, illite, kaolinite etc.) and other matter hold together framework serving the nutrient base. The humus and colloidal clay are endowed with capacity for cation exchange and thus chemically active. It also has capacity to hold the water and hence remain moist even during dry season and permit microbial activities and hence capable of supporting vegetation. Geologist thought soil is only upper part of the weathered material resting on bedrock and containing inorganic and organic nutrients. But an environmentalist it is dynamic living layer forming the foundation for all ecosystem.

There are two major categories of soil i.e. zonal and azonal or drift. The zonal soil occurs usually in relatively flat or undulating areas
formed as result of weathering. Where as azonal are formed by mass movement deposits and are thus transported soils. These soils are classed on the basis of minerals, chemical composition and texture (Annon, 1975). On the basis of morphology, nutrient status, quantity of organic matter, color and general climatic consideration soils are placed in to ten general categories (Keller, 1976; Olson, 1981). The large part of peninsular of India is covered by soils formed under climatic conditions (hot-dry and hot-wet), which favor dissolution and leaching of nutrients. The soil composition varies from place to place depending on parent rock. The Deccan and Malva platue (which cover most part of Maharashtra, M.P.) build up of basaltic lava and pyroclastic contains black and loamy soils having pH 6 to 8. Which is characterized by carbonates of calcium and magnesium and oxides of alluminum (<10%), iron (9-10%) small amount of potash (0.5%) and trace of phosphorus, which make soil fertile in nature (Wadia, 1975; Kulkarni, 1986).

The soils in India also classified in eight groups as, red, lateritic, alluvial, black, forest, desert, and saline-sodic and peaty and marshy soils. Red soils occur extensively in Andhra Pradesh, Assam, Bihar, Goa, Parts of Kerala, Maharashtra, Karnataka, Tamilnadu and West Bengal. These soils contain various oxides of iron, but are poor in NPK. The pH of these soils ranges from 7 to 7.5. Lateritic soils are distributed in Daccan Karnataka, Kerala, Madhyaprades, West Bengal, Tamilnadu, Assamand Ghat regions of Orissa, Andhra Pradesh, and Maharashtra. These soils are rich in oxides of silica, iron and aluminum with low pH and CEC. Alluvial soils have low NPK and humus. The pH of such soils is within 7 to 8 with low CEC. These soils
are distributed in Indo-Gangetic plains, Brahmaputra valley and all most all states of North and South. Black soils are having high CEC with high pH and rich in lime and potash. Major black soils are found in Maharashtra, Madhyapradesh, Gujarat and Tamilnadu. They are neutral to slightly alkaline in reaction. Forest soils are occurring in Himalayas having more acidic and dark brown with more sub-soil humus content. Desert Soils contains large amounts of soluble salts and lime with pH ranging 8.0 to 8.5. The presence of phosphate and nitrate make the desert soils fertile and productive under water supply. They are distributed in Haryana, Punjab, Rajasthan. Peaty and Marshy soils are found more in Kerala and marshy soils are found more in coastal tracks of Orissa, West Bengal and South-East coast of Tamilnadu. These soils are highly acidic with pH of 3.5. Free aluminum and ferrous sulphate are present in such soils. Saline-Sodic Soils Saline soils contain excess of natural soluble salts dominated by chlorides and sulphate, which affects plant growth. These soils contain high exchangeable sodium salts and occur in parts of Uttarpradesh, Haryana, Punjab, Maharashtra, Tamilnadu, Gujarat, Rajastan and Andhra pradesh.

Soil pollution is any chemical or biological alteration of soil that is harmful to living organisms. Virtually all soil pollution is the direct result of sources of pollution on the ground surface. The percolations of these surface pollutants through the soil cause soil degradation. Pollution on the ground surface is the cause of most soil pollution. This surface pollution comes from many sources like waste (solid or liquid) disposal practices, spills, agricultural practices and percolation of surface pollutants through unsaturated soil etc (Mahida, 1987).
When any liquid pollutant is on or just below the ground surface for any period of time, one of three things could happen to it. Firstly, the pollutant might be washed away by precipitation, causing little or no harm to the ground on which it was found. Secondly, the pollutant, if volatile, could evaporate, again causing little or no harm to the ground on which it was found and. Thirdly, the pollutant could infiltrate through the unsaturated soil, in much the same way as ground water. Thus percolation of surface pollutants through soil has two major negative effects, soil degradation, and contamination of ground water,

However, agriculture and agro based industries, which depends directly or indirectly with the soil as a result, is bound to have some effects on the make up of the soil. The use of pesticides and fertilizers as well as disposal of effluent in streams or on land has come under scrutiny for many reasons (Prashanthi and Jeevanrao, 1999). One of the most harmful ecotoxilogical effects is that of the eutrophication of water bodies. This occurs due to over use and bad management of phosphorous and nitrogen fertilizers and contaminated wastewater for irrigation. It leads to over productivity in the water body and eventually to deoxygenating of the water, meaning that more fragile populations and communities cannot survive. This has many implications, not only for the environment and wildlife involved but it may also affect human activity such as drinking water, or leisure activities like swimming in the well for human, for livestock and also for irrigating crops.

Bioaccumulation and biomagnifications of these poisons as they move along the food chain is also a major problem, which has influence
on the whole ecosystem. This activity coupled with use of contaminated water will raise salinity and/or alkalinity to the soil.

The unscientific agricultural practice and unplanned irrigation cause reduction in permeability and roughness leads to infertility of soil. In such situation shallow topsoil become saturated with water in shorter period and concentration of salts dissolved in it starts during dry season. These salts in rainy season start to leach down in soil and gives problem like salinity or and alkalinity (Mahida, 1987). Amongst these effect alkalization is more important that Salinization of soil. Soil can only continue to be suitable for plant if salt concentration along with exchangeable sodium being low. Stalinization is the process of salt accumulation in the soil. When salts accumulate in the soil and as sodium salts become more concentrated in soil solution, greater quantities of sodium will adsorbed and when its percentage will increase the soil become alkaline in reaction and process of alkalization starts.

Saline soil contains sufficient soluble salts to interfere with growth of most crops. pH of such soil usually remain low i.e. <8.5 as well as exchangeable sodium is below 15% to the total exchangeable cations. Such soils are in flocculated condition leached excess salt below the root zone by irrigation water (Daji, 1985)

The saline alkali soil contain appreciable quantities of neutral salts and also enough adsorbed sodium usually more that 15% to the total exchangeable capacity. These soils seriously injure the crops. Leaching of salts from this soil during irrigation rise the pH of such soil markedly.
Non saline alkali soil do not contain large amount of neutral salts. The exchangeable sodium is much more than 15% to the total cation capacity and hydrolyzes freely as the concentration of neutral soluble salts is low (USDA, 1954). Therefore, pH of such soil remains more then 8.5. Because of high exchangeable sodium content, both the clay and organic matter dispersed. Due to deflocculating influence of sodium, these soils are in unsatisfactory physical condition. The close packing of soil particle reduces the size and amount of pore space, there by reducing the permeability soil both to air and water.

During the dry season both saline and saline-alkali soils often accumulate a conspicuous white coating salts on surface and termed as white alkali. Saline alkali soil when leached without available calcium can replace sodium; result in non-saline alkali soil. Removal of the soluble salts from the high sodium saturated soil due to leaching by irrigation deflocculates such soil resulting in formation of tight structure unfavorable for irrigation and drainage. The high alkalinity leads to formation of soluble organic complexes which coat the soil particle dark color termed as a black alkali soils. Hence, common danger of possible deterioration of soils in unplanned irrigation area and due to unscientific agriculture practices is observed in most of the cases (Valdiya, 1987). High salt concentrations in the soil prevent the uptake of water and essential nutrients by plant roots. This, in turn, restricts plant growth and reduces crop yields. Groundwater flowing through these deposits dissolves and transports the salts. Under certain conditions, groundwater rises to the soil surface where the water evaporates, leaving the salts behind. Over time, the salts accumulate on the soil surface. A white salt crust forms where the salt concentration is
very high. Only salt-tolerant plants grow in this visibly saline area (Hendry, 1970). The land around the visibly saline area will also have saline subsoil, resulting in reduced crop yields.

Irrigating with water that has excess amounts of sodium can adversely impact soil structure, making plant growth difficult. Highly saline and sodic water qualities can cause problems for irrigation, depending on the type and amount of salts present, the soil type being irrigated, the specific plant species and growth stage, and the amount of water able to pass through the root zone.

Saline irrigation water contains dissolved substances known as salts. In much of the arid and semi-arid zone most of the salts present in irrigation water are chlorides, sulfates, carbonates, and bicarbonates of calcium magnesium, sodium, and potassium. Though, salinity improve soil structure, it can affect plant growth and crop yields negatively.

Sodicity refers specifically to the amount of sodium present in irrigation water. Irrigating with water that has excess amounts of sodium can adversely impact soil structure, making plant growth difficult. Highly saline and sodic water qualities can cause problems for irrigation, depending on the type and amount of salts present, the soil type being irrigated, the specific plant species and growth stage, and the amount of water able to pass through the root zone (Bauder and Brock, 1992, 2001). Similarly it will change most physical and chemical properties of the soil like, pH, EC, cation exchange capacity, and percentage of salts (Baker et.al, 2004). Salinity becomes a problem when enough salts accumulate in the root zone to negatively affect plant growth. Excess salts in the root zone hinder plant roots from
withdrawing water from surrounding soil. This lowers the amount of water available to the plant, regardless of the amount of water actually in the root zone. For example, when plant growth is compared in two identical soils with the same moisture levels, one soil receiving salty water and the other receiving salt-free water, plants are able to use more water from the soil receiving salt-free water. Although the water is not held tighter to the soil in saline environments, the presence of salt in the water causes plants to exert more energy extracting water from the soil. The main point is that excess salinity in soil water can decrease plant available water and cause plant stress. Soil water salinity is dependent on soil type, climate, and water use and irrigation routines (USDA, 1954).

Soil water salinity can affect soil physical properties by causing fine particles to bind together into aggregates (Bekar et al., 2004). This process is known as flocculation and is beneficial in terms of soil aeration, root penetration, and root growth. Although increasing soil salinity has a positive effect on soil aggregation and stabilization, at high levels salinity can have negative and potentially lethal effects on plants. As a result, salinity cannot be increased to maintain soil structure without considering potential impacts on plant health.

Sodium, which gives sodicity, has the opposite effect of on soils. The primary physical processes associated with high sodium concentrations are soil dispersion and clay platelet and aggregate swelling. The forces that bind clay particles together are disrupted when too many large sodium ions come between them. When this separation occurs, the clay particles expand, causing swelling and soil dispersion. Soil dispersion causes clay particles to plug soil pores,
resulting in reduced soil permeability. When soil is repeatedly wetted and dried and clay dispersion occurs, it then reforms and solidifies into almost cement-like soil with little or no structure. The three main problems caused by sodium-induced dispersion are reduced infiltration, reduced hydraulic conductivity, and surface crusting. Salts that contribute to salinity, such as calcium and magnesium, do not have this effect because they are smaller and tend to cluster closer to clay particles. Calcium and magnesium generally keeps soil flocculated because they compete for the same spaces as sodium to bind to clay particles. Increased amounts of calcium and magnesium can reduce the amount of sodium-induced dispersion (Daji, 1985). Soil dispersion hardens soil and blocks water infiltration, making it difficult for plants to establish and grow. The major implications associated with decreased infiltration due to sodium-induced dispersion include reduced plant available water and increased runoff and soil erosion (Lado et.al, 2004). Soil dispersion not only reduces the amount of water entering the soil, but also affects hydraulic conductivity of soil. Hydraulic conductivity refers to the rate at which water flows through soil. For instance, soils with well-defined structure will contain a large number of macro pores, cracks, and fissures, which allow for relatively rapid flow of water through the soil. When sodium-induced soil dispersion causes loss of soil structure, the hydraulic conductivity is also reduced. If water cannot pass through the soil, then the upper layer can become swollen and water logged. This results in anaerobic soils, which can reduce or prevent plant growth and decrease organic matter decomposition rates. The decrease in decomposition causes soils to become infertile, black alkali soils (Yaron and Thomes, 1968).
Surface crusting is a characteristic of sodium-affected soils. The primary causes of surface crusting are 1) physical dispersion caused by impact of raindrops or irrigation water, and 2) chemical dispersion, which depends on the ratio of salinity and sodicity of the applied water. Surface crusting due to rainfall is greatly enhanced by sodium induced clay dispersion. When clay particles disperse within soil water, they plug macro pores in surface soil by two means. First, they block avenues for water and roots to move through the soil. Second, they form cement like surface layer when the soil dries. The hardened upper layer, or surface crust, restricts water infiltration and cation exchange capacity of soil coupled with plant emergence (Daji, 1985; Mahida, 1987; Mamedev et al., 2000).

Cation-exchange capacity of soil is, the degree to which a soil can adsorb and exchange cations. Cation—a positively charged ion such as NH$_4^+$, K$^+$, Ca$^{2+}$, Mg$^{2+}$ Fe$^{2+}$, etc. Soil particles and organic matter have negative charges on their surfaces, so naturally it attract positively charge nutrients and replace negatively charged nutrients (Christan, 2004). This explains why cations find easy home in the soil while anions are repelled and easily leached out of the soil. But just because a cation has a positive charge doesn't mean that it can't be leached out of the soil. In slightly acidic and neutral soil the Ca$^{2+}$ and Mg$^{2+}$ account for 80% or more of exchangeable cations while K$^+$ accounts only for few %. However CEC is depends on soil texture and clay. Generally, higher the clay and organic matter, more the CEC in the soil (Daji, 1985; Donahau et al., 1987)). Clay content is important because these small particles have a high ratio of surface area to volume The soils rich in montmorillonite clay are high in CEC while those having
kalolinite as the predominant clay mineral have low CEC (Daji, 1985). The CEC of kalinite bearing soils is in the range of 3-15 meq/ 100 g. On the other hand, soils with hydrated alloysite has higher CEC in the range of 40 to 50 meq/ 100 g (Raymahashay et al, 1984). The CEC of most soils increases with an increase in soil pH. Hence, most of the cations availability is depend on pH of soil. Because, as pH increases (becomes less acid), the number of negative charges on the colloids increase, thereby increasing CEC. Additionally, high levels of one nutrient may influence uptake of another. Some times high levels of Ca limit K uptake by plants. High levels of K can in turn; limit Mg uptake even if Mg levels in soil is high (USDA, 1954).

Thus soil will become unfertile, unproductive, waterlogged, or dry due to industrial effluent discharge on soil or when such effluent percolated in ground water and this groundwater when applied to soil for irrigation purpose at many places in arid or semiarid zone. The review of literature given above indicates that the problem of water and soil pollution is threatening rural population. The people of villages are still dependent on traditional sources of water supply like fetching of water directly from rivers, canales, and community wells and bore wells in water scarcity areas. Since, many of such water supply are unfit for human use, rural population is under the grip of different epidemic throughout the year (Sidhathan et.al., 2000; Narian and Chavan, 2000; Patil and Tijare, 2001).

In addition to the industrialization, the wrong practice of agriculture has also adversely affected the soil and surface as well as groundwater quality. Now days identified major sources of groundwater pollution in the rural areas are surface percolation of
wastewater emerging from agro base industries like Sugar, Paper and pulp, Distilleries etc. (Kundra and Purthy, 1979; Maid and Shimpi, 1984; Senthilkumar, 2001). The disposal of such wastewater with partial or without any treatment by the industries has been a cause of deterioration of groundwater quality, adversely affecting water supplies for different purpose. Similarly, increasing use of pesticide, insecticide and fertilizer to raise the production of crops has resulted in incipient degradation of soil as well as ground water quality in rural areas.

The comprehensive account of chemistry of surface as well as on groundwater and soil have been carried out by number of workers during last few decades in the rural part of our country as well as in the state of Maharashtra. Hausenbuiller et.al (1960) given some effects of irrigation waters of different quality on soil properties. Singh et.al (1967) carried out preliminary studies on the effect of irrigation water on the properties of soil of Jobner Tract. Gupta (1969) carried out studies on the quality of ground water in the northern part of Meerut district, Utter Pradesh. Paliwal and Maliwal (1971) studied relation between constituents of irrigation waters and properties of irrigated soils of western Rajasthan. Deshmukh (1973) showed chemical quality rating of Karnataka to study the effect of industrial effluents on the down stream sources at Belgoan. Gupta et.al (1984) reported physico-chemical and mineralogical studies on some Kashmir valley soils. Pawar (1985) has highlighted the effect of urban and industrial developments of Pune Metropolis on the surface and ground water chemistry. Bharti and Krishna Murthey (1990) shown effect of industrial effluent on river Kali around Danderi, Karnataka. Desai (1995) studied water qualityof Dudha Sagar river of Dudhasagar, Goa.

Therefore, taking in to account several factors affecting the water quality and also the dependence of rural population on groundwater as a chief source of drinking water and for agriculture. The present investigation was carried out to assess the impact of agrobase industries on the quality of groundwater and soil from the Sonai area, in the Ahmednagar district of Maharashtra state.

1.4 Sonai Area:

The Sonai area is located in the Newasa Tahsil of Ahmednagar district in the Maharashtra state. It covers an area of 15.12 square
kilometer and is included in the toposheet number 471/15 of the survey of India and lies between 19°22’ to 19° 24’, N latitude and 74° 49’ to 74° 51’ 46.6” E longitude (Figure 1). The important places in area are Shani Shingnapur, Sonai, Mula Sugar factory etc. The area is connected with tar road from Ahmaednagar-Aurangabad highway at east as well as Ahmednagar-Manmad highway at west. As the area falls in rain shadow zone, it receives average rainfall around 600mm from southwest monsoon only in rainy season; hence the climate of the study area is generally observed dry. The maximum temperature during summer reaches as high as 41°C whereas minimum temperature is as low as 10 °C during winter.

The Sonai area is interesting to study because almost one third of the area is under single crop cultivation (Sugarcane) for the last three decades. The sugarcane cultivation is due to the adequate facility of water through the Mula right bank canal and from its aqueducts originating from Mula Dam, with water storage capacity of 26 TMC. It is located near Baragaon Nadur village in Rahuri Thahsil of Ahmednagar district towards western side of the study area and is about 27 Kilometer away from Sonai. This dam is providing water for agriculture in the study area since 1971. However, due to change in government policies in 1986, the water supply for agriculture is only eight months instead of through out the year. This change is perhaps due to overuse or unplanned use of irrigation water in the beginning, which has caused waterlogging problem in some places including the problem of water and soil salinity. Water for irrigation in study area are also supplemented by the wells and bore wells.
Figure 1: Location map of the study area.
The agro base industry i.e. Mula Sugar factory having its allied units like Distillery and Composting in the area started in 1979 with a capacity of 1250 tone crushed per day (TCD). In 1987, the initial capacity was expanded to 2000 TCD and now with again successful expansion the capacity increased to 2800 TCD. For such huge crushing large amount of water is required. It requires nearly 1500-1700 liters/ton/day. With all internal processes, the water comes out from the boiling house, mill house and filter cloth washing as an effluent. This effluent with very little partial treatment in effluent treatment plant goes through zigzag natural earthen stream. The stream flows about two kilometers through the agricultural area (Fig.2). While flowing the effluent percolates in the soil, nearby wells and bore wells adversely affecting the natural ground water quality by changing its chemical and biological composition.

Similarly, large quantity of distillery effluent termed as a spent wash created after distillation is stored in lined lagoons, which resembles as storage pit. From this, some spent wash is used for composting. In rainy season the spent from this pits percolate in to the ground and meet to water table affecting chemical quality and color of water (Fig.3and 4).

Further, during each month there is a cleaning operation of factory, which releases a lot of effluent containing organic and inorganic matter in to the stream. Due to the large volume of effluent, and because of low water carrying capacity, the stream get flooded at some places and spreading of effluent over cultivated land occurs (Fig.5). In effect soil in this area have become sterile leading to contamination of soil.
Figure 2: Showing earthen effluent stream in agricultural area.

Figure 3: Showing change in color of well water.
Figure 4: Showing change in color of well water.

Figure 5: Showing spareded effluent on cultivable land.
From foregoing discussion it is clear that the study area is experiencing a lot of interplay between natural water and effluent through the medium of soil. It should be noted that the water from this area was uncontaminated and wholesome before installation of the sugar factory. However, the residence of this area that are utilizing this water for different use, have realized the change in the quality of water and soil after advent of the factory. The effluent stored in lagoons and pits, and later released in the stream has undergoing percolation through the soil and contaminated nearby wells and bore wells.

1.5 Aims and Objectives:

From the above discussion it is clear that Sonai area facing the environmental problems of groundwater and soil due to interaction with sugar mill wastewater. It was intended to study the different aspect of water chemistry, water quality and soil characteristics from the study area. To investigate these aspect it is necessary to examine the ground water quality of the area and to evaluate the causes t led to the variations in the characteristic of the groundwater and changes in the soil salinity and/or alkalinity. The objective of the study under investigations are

1. To understand the modus operandi for carrying out the field and laboratory work on the groundwater and soil chemistry.

2. To carry out chemical analysis of groundwater to establish the pattern of change in the water quality parameters.

3. To evaluate the sustainability of water for drinking and agriculture purpose.
4. To study the chemical composition of soil to understand the trend of development of salinity and/or an alkalinity in the study area.

It was, therefore, decided to investigate water and soil quality in the Sonai area with the hope that the finding will be valuable to others who may subsequently utilize the data in more details. The findings and conclusions arrived after the investigation will also have some practical importance in planning and management of water and soil for various purposes and will be useful in the agrobase industrial sector of the Maharashtra state.