CHAPTER VI

CHAPTER VI

DISCUSSION , CONCLUSION AND RECOMMENDATIONS

Discussion:

Kolhapur district has 12 towns and 1203 villages spread in 12 tahasils. The city has three water treatment plants to provide clean water. It is observed that in the last few decades drinking water supply in urban areas have improved substantially over its rural counterparts and which now receives more than two third of the total supply. However, the quality and quantity of water available remains unsatisfactory in most of the semi-urban areas and fringe villages.

Considering these facts, four villages around Kolhapur city are selected for the present study on quality of drinking water around Kolhapur city. During the course of study, potable water samples were divided into five different categories in order to test the hypothesis and to find out the causes, if any, of drinking water pollution faced by these villages.

To get brief idea regarding water facilities and its quality and availability, primary survey was carried out. It helped to select the sampling sites and the parameters for water analysis. A random stratified sampling schedule was adopted for water collection. The water samples from all the sites in the village were collected on the same day and similarly studied for the three seasons in one year. This research design helped to focus on the changes in water quality and its availability during different seasons.

A total of 19 sites were finally selected form the five different categories among them were three ground water sources viz. hand pumps, bore wells and open wells. Also for comparison two tap water categories viz. KMC water supply and Grampanchayat water supply were selected.

During the course of the study it was observed that as compared to rainy and summer seasons electrical conductivity, turbidity, total solids, total dissolved solids, and

alkalinity decreased in winter season. This is because in summer, due to less water pollutants get concentrated, where as in rainy season higher amount of dissolved materials from the runoff increase the value of the parameters.

pH values of the samples were in the range between neutral to slight alkaline. pH being the measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions present in water. It does not calibrate total acidity or alkalinity. The majority of the waters were slightly basic because of the presence of carbonates and bicarbonates.

A number of bases such as carbonates, bicarbonates, silicates, borate etc. contribute to the alkalinity. In natural water most of the alkalinity is caused due to free carbon dioxide. The highest and lowest alkalinity recorded were at BR1 and CP3 sites respectively. The standard limit for alkalinity is 200 mg/lit, however the sites HP1, HP4, BR1, BR2, BR3, BR4 and W1 crossed this limit and the remaining sites showed alkalinity levels below this limit. Large fluctuations were observed in the alkalinity levels at HP1, HP4, BR1, BR2 and BR3 sites. Alkalinity showed slight positive correlation with chlorides and nitrates.

Water temperatures recorded during the summer and rainy season were found to be somewhat similar and were comparatively higher than the temperatures recorded during winter season. Increased temperature is favourable for growth and multiplication of most of the micro-organisms. And therefore it is assumed that their activity would be ore enhanced during this season.

Regarding the total hardness values, hand pump, bore well and open well water samples categorised between moderate to very hard water. Grampanchayat and KMC water supply samples were in the range of soft to moderate hard according to the classification of ground water for hardness (Sawer and McCarty, 1967)

Hardness values increased in rainy and summer seasons as compared to winter. The highest hardness values were recorded from sites BR6, W2 and HP4 respectively. Social survey reports showed that hard water was responsible for health hazards such as kidney or urine stone, hair loss, drying and etching of skin. It also develops white spots on cooking utensils.

It was revealed that the calcium and magnesium values vary as per the hardness values. Hardness showed excellent to good correlation with Ca^{++}, Mg^{++}, total solids, total dissolved solids, chloride and free CO_2 respectively.

Among all ground water sampling sites, BR6, W2 and HP4 sites showed highest hardness values respectively whereas lowest hardness was recorded from HP5 and BR5 sites.

Dissolved oxygen recorded was very low for ground water samples as compared to Grampanchayat and KMC water supply samples. But among ground water samples, hand pumps showed minimum DO as compare to bore well and open well. it may be due to reason that bore well water comes forcefully from tap and gets easily aerated. Similarly in open wells surface area oxygen gets easily dissolved in well water. Also water from KMC supply is aerated during the water treatment and leading to increase DO level. Correlation coefficient values showed that DO is negatively correlated with other physicochemical parameters.

Among the ground water samples the highest free CO_2 value recorded was from BR1 and lowest from W3 sites respectively. The Grampanchayat and KMC water supply showed less free CO_2 as compared to ground water. This justifies the reason of re-carbonation of water during the last stage of water softening. Surface water normally contains free CO_2, which is less than 10 mg/lit.; while ground water may easily exceed the concentration up to 30-50 mg/lit. Free CO_2 showed significant positive correlation (0.590) with alkalinity value.

Turbidity is associated with suspended matter and microbial growth. Seasonal analysis showed that for most of the samples turbidity increased in rainy and summer seasons as compared to winter. Among the ground water categories comparatively bore wells showed lower turbidity values as compared to hand pumps and open wells. Open wells have higher turbidity as they are open structures and external interference causes the observed changes.

The maximum turbidity values were recorded at HP3, HP4, BR4, W1. It is important to note that in summer turbidity values are on the upper boundaries of standard limit. All samples exceed the highest desirable limit of 5 NTU

.

All total solids values were within maximum permissible limit of 1500 mg/lit, except HP4 (rainy season), BR6 (summer and rainy season) and at W2 (Rainy season). Suspended material in water is objectionable as it provides settling sites for chemical and biological agents.

Conductivity values were roughly proportional to the total dissolved solids. Dissolved solids are mainly the minerals present in water. Organic impurities in water also contribute to dissolved solids. According to ICMR and WHO maximum permissible limit for TDS is 1500 mg/lit. All samples studied were below this limit.

Ground water containing more than 1000 mg/lit of TDS are considered as saline water and TDS levels greater than 1200 mg/lit in drinking water becomes increasingly non potable. Only two water samples collected from BR6 and W2 in rainy season showed TDS values greater than 1000 mg/lit. Also the potability of water with TDS values less than 600 mg/lit is generally considered good for health. HP1 (rainy season), BR1, BR2, BR3 and W3 showed TDS greater than 600 mg/lit in rainy and winter season.

Electrical conductivity for ground water samples collected from HP_4 and BR_5 sites were within the std limit of 300 umhos/cm (ICMR) in all season. Remaining all samples exceeded the standard limit of 300umhos/cm. The KMC water samples showed electrical

conductivity within the standard limit. Grampanchayat water sample collected from GP_1 was within limit but from GP_2 was in excess.

According to the classification given by USPA (1974), all ground water samples were in the range of low to medium electrical conductivity, except at BR6, W1 and W2 sites, in rainy season, which showed higher conductivity.

Man and other animals excrete high quantities of chlorides together with nitrogenous compounds. Industries are also important sources of chlorides. Most of the water samples studied where within the maximum permissible limit (WHO, ICMR, MWH, BIS), only BR6, W2 and W3 exceed the highest desirable limit of 1000 mg/lit.. HP3 and W1 sites showed large fluctuations in the chloride levels and W2 and CP3 sites showed the highest and lowest chlorides values respectively.

In case of nitrates all the samples were below the standard limit of WHO, ICMR and MWH i.e. 45 mg/lit, except at BR4, BR6 and W3 which crossed the highest desirable limit of ICMR (20 mg/lit). The overall maximum and minimum nitrate values were recorded from BR4 and CP2 sites respectively. Surface and ground water is contaminated with nitrate mainly due to sewage and agricultural runoff. When nitrate concentrations exceeds 40 mg/lit in drinking water, it causes disease known as Methaemoglobunemia.

Water samples collected from hand pumps, bore wells, open wells, Corporation and Grampanchayat sources were analysed for concentration of Heavy metals Cu, Zn, Mo, Fe, Cd, Ni, Mn, Co, Pb and the values were compared with the standards of WHO, USPHA, Ministry of Works and Housing Report 1975, BIS, which have recommended safe limits for the concentrations of these metal ions in drinking water.

Iron concentration recorded from all sampling sites exceeds the highest desirable limit of 0.3 mg/lit. but below maximum permissible limit of 1 mg/lit. except at GP2 site where it crossed this limit. Due to the high concentration of iron, water is rendered

tasteless and odorous and finally not fit for human consumption. This high concentration also supports growth of iron bacteria, resulting in clogging of pipes.

All water samples showed copper concentration below the standard limit of 0.05 mg/lit. except GP2 site, which slightly exceeded the highest desirable limit. Copper in large does is known to be dangerous to infants and people with certain metabolic disorders. On other hand, lack of copper intake causes anaemia, growth inhibition and blood circulation problem.

The serious finding of the study is the high values of some heavy metals in the drinking water samples. All water samples revealed values above the standard limits for cadmium, nickel, manganese, cobalt and lead. Lead values were in excess of other heavy metal values at all site except at W2, BR6 and GP2 sites where it was absent. It is alarming to note that all samples showing lead concentration had values much excess of safe permissible limit.

In case of molybdenum all the sites except two, HP2 and BR2, showed values beyond the standard limit of 0.07 mg/lit. . Mo itself is moderately toxic, producing loss of appetite, nausea, listlessness and diarrhoea. A frequent symptom of Mo poisoning is anaemia. All water samples showed zinc concentration much below the prescribed limit.

Due to use of contaminated water, the population suffers from a variety of water borne diseases. The main causes of deterioration of drinking water are the seepage from drains, lack of proper sanitation facilities and use of insecticides and pesticides. All water samples in the study area except from KMC water supply showed faecal contamination.

The coliform groups of bacteria are considered to be indicator organisms and their presence in umpteen numbers strongly suggests the presence of other pathogenic bacteria. However, their low number in water is generally regarded normal since they are commonly present in water.

Present investigations indicated the increasing trend of microbial pollution as evidenced by the high MPN values in the water samples. These values increased during rainy and summer seasons as compared to winter season.

As prescribed earlier Most Probable Number (MPN/100ml), Standard Plate Count (SPC/ml) and detection of *Salmonella* spp. was carried out during the course of study. Large fluctuations were observed in MPN/100ml and SPC/ml values depending on season and for different locations and categories. According to the study all ground water sampling sites are significantly polluted. *Salmonella* sp. was isolated from four out of nineteen sites i.e. HP4, BR6, W1 and W2.. It was observed that *Salmonella* was absent in the water samples from KMC and Grampanchayat.

For all sites of KMC water supply MPN count was absent. Though generally it was absent from the Grampanchayat samples, only in rain season at both the sites GP1 and GP2 the count was 4/100ml and 14/100ml respectively.

In ground water samples, considering the average value of three seasons, W2 site showed the highest count of coliform (1907/100 ml) and the lowest (4/100ml) was recorded from W3 site. Among the ground water samples, according to the MPN test the hand pumps were least polluted as compared to bore wells and open well.

When only hand pumps are considered, HP1 site gave least MPN count when HP4 recorded highest count. Large fluctuations were observed for the three seasons at HP4 and HP5 sites. Only HP4 site showed highest count of $\geq$ 2400/ 100ml in rainy season. This was because the site was located near the garbage dump and stagnant waste water location.

Among the bore wells, it was interesting to note that BR3 and BR5 sites showed same MPN count for the three different seasons. When BR4 was the least polluted site, BR3 and BR5 were the highest polluted bore wells. Maximum fluctuations were observed at BR1 and BR6 sites.

In case of open well sites W1 and W2, both showed MPN count of ≥ 2400/ 100ml in rainy and summer seasons. The lowest and highest MPN counts were recorded at W3 and W2 sites respectively.

Generally SPC is used to test the bacterial density of water samples. The SPC provides a method for monitoring changes in bacteriological quality of treated water. Generally water deficient in oxygen provides shelter for bacteria and other pathogens, which are anaerobic and injurious to human health.

In the ground water samples, as an average value of three seasons, HP4 site showed the highest SPC count of 13066/ml and the lowest count of 4450/ml.was reported from W3 site. It is interesting to note that among the ground water samples, according to SPC count, open wells were the least polluted as compared to bore wells and hand pumps. The over all lowest SPC count was observed for KMC water samples.

In hand pump category only HP4 site gave highest SPC count of 17240/ml in summer and lowest of 3307/ml IN HP1 site in winter season respectively. Except at HP4 rest of the sites recorded higher values in rainy season . Among the bore wells BR1site gave the least SPC count of 2687/ml in winter where as the highest count of 13365/ml was recorded at BR6 in rainy season. The SPC count was more in summer in all the sites except BR5 and BR6.

In case of open wells 2700/ml and 10860/ml was the minimum and the maximum SPC count recorded from W1 and W2 sites in winter and summer season respectively.

KMC water supply gave least SPC count of 203/ml at KMC tap1 in summer and highest of 1027/ml at KMC tap 3 in rainy season. Large fluctuations were observed for three seasons at KMC tap 3 site. Water samples collected from Grampanchayat showed minimum SPC count of 1317/ml in rainy season and 1787/ml in summer from the same site GP1.

It is very interesting to note that, in case of ground water samples, according to average MPN count,. hand pumps are less polluted (457/100ml) and open wells are more polluted (1171/100ml). Where as per the average SPC count, hand pumps are more polluted (7428/ml) and open well are less polluted (5543/ml). This is mainly because in MPN only coiform group of organisms are considered as indicator organisms of pollution. Were as in SPC entire water microflora is counted. In general this indicates that the drinking water supply from ground water in the study area is seriously polluted.

The social survey in the study area revealed very important data related to the local people's perception about the drinking water problem. It is striking that even the villages on the outskirts of Kolhapur city, one of the most prosperous region in the country as per GDP, can not have clean and safe drinking water facility even after e 56 years of independence. The transformation that has come about in the villages and improvement in the living standard of rural masses does not seem to have much impact on the drinking water quality.

Which is reflected in lack of safe drinking water and hygienic conditions in the study villages. The implications of water pollution for the health and well being of people are serious. Considering that two- third of all illnesses in India are related to waterborne diseases, the case of study area is not any different.

It was revealed from the interaction with the 57 respondents from the four villages that , the problem of lack of clean water is two fold, i.e. adequate water as well as quality of water if available in sufficient quantity. The major cause appeared to be the life style of people. Even if many of the respondents refereed to personal hygiene, the public or community hygiene conditions were far from satisfactory.

Lack of water results in a poor standard of personal hygiene. An adequate supply of pure drinking water and sanitary disposal of human excreta are not only essential for the prevention of some of the diseases but also for a decent standard of living. There is probably no single factor that has greater effects on the health, well being and

development of community than the provision of ample and convenient supply of wholesome and good quality water.

According to recent report of the Government of India, only 10 % of our rural population is at present served with piped water supply system and hand pump fitted tube wells. Probably another 10 percent may also have reasonably safe water supply from protected wells. However, in the study area water from both the sources was significantly contaminated due to poor maintenance, awareness and apathy..

In Maharashtra, in the recent years there is a serious problem of unsafe drinking water. During summer, the only major activity of the people in majority of the villages is to collect drinking water at any cost. Due to scarcity of water, people move towards unsafe water. However, in the study area despite satisfactory rainfall and minimum adequacy of water , people suffer from poor water quality. This is primarily related to exploitation, misuse and abuse of drinking water resources for wrong priorities.

Conclusions:

Some of the conclusions of the study are given in brief as follows.

- Despite good average annual rainfall of about 100 cms/.yr in and around Kolhapur city, locals do not have safe drinking water in adequate quantity.
- It was revealed that ground water pollution is dependent on seasons. Water was least polluted during winter season as compared to rainy and summer seasons.
- It was observed that as compared to rainy and summer season, electrical conductivity, turbidity, total solids, total dissolved solids, alkalinity values decreased in winter season. Because in summer, due to less water pollutants gets concentrated. In rainy season due to higher amount of dissolved material and runoff it gets increased.
- During the course of study it was observed that among the hand pumps HP4, among bore wells BR6 and among open wells W2 were the most polluted sites.
- Dissolved oxygen recorded was very low for ground water samples as compered to water samples from Grampanchayat and KMC taps.

- Turbidity is associated with suspended matter and microbial growth. It was found that turbidity increased in rainy and also in summer season.
- Ground water samples from most of the sources mainly contaminated with nitrates and chlorides mainly due to sewage and chemical fertilisers used in fields.
- According to MPN test KMC tap water samples were free from faecal contamination. Whereas Grampanchayat water samples showed few MPN count only in rainy season and among ground water samples hand pumps showed minimum MPN count as compered to bore wells and open wells.
- *Salmonella sp.* was detected from four site as HP4, BR6, W1 and W2 during study.
- In case of heavy metals only zinc concentrations were much below the prescribed limit. In few water samples iron, copper and molybdenum concentrations exceed the standard limit.
- The serious findings of the study is the high values of cadmium, nickel, manganese, cobalt and lead in drinking waters. All samples revealed values above the standard limits. Except lead ,which was absent at three sites, it is alarming to note that all samples showed lead concentration values much in excess of safe permissible limit.
- It is observed that majority of hand pumps are located on roadsides near sewage gutters. In Nagadevwadi and Tamgoan, number of hand pumps was less and most of them were not in working condition.
- Most of the open wells are located in agricultural fields. In many places well water was used for agricultural, domestic and also for drinking purpose.
- Among the study villages Tamgoan had inadequate water supply in summer hence some of the residents even for drinking used polluted water sources.
- Most people complained about the shortage of clean drinking water supply. They also expressed their concern about government's apathy and reluctance for improving the present water sources or repairing them.
- Majority of the population in the study villages suffered from water related health problems in rainy and summer season.

Recommendations:

- Provision of safe drinking water supply and adequate sanitation facility in each village is undoubtedly an effective preventive measure through which health of the people can be protected to a great extent.
- As compared to the available ground water sources in the study area KMC water supply being cleaner , attempts should be made to provide adequate drinking water through taps by KMC. However, heavy metal should be within limits
- Drinking water, which is provided by Grampanchayat water supply, in Nagdevwadi and Tamgaon, should be free from pathogenic micro-organisms and excessive amount of heavy metals.
- Excess use, exploitation or abuse of ground water, wherever possible, must be avoided. This leads to the depletion of ground water levels and available quantity.
- Also there is need of collective ground water management and monitoring of water quality and availability at village level
- Both surface and ground water should be regularly monitored for its quality.
- The necessary treatment for the present problems of chlorides, salinity, bacteriological contamination, high concentration of heavy metals be initiated by using appropriate technology.
- There is need of improving, recharging of ground water and also developing the traditional water retention structures in the village surroundings by using appropriate technology.
- The quality of water should be such that it is suitable for human consumption and for all usual domestic purposes, including personal hygiene.
- Monitoring of water quality is required to undertake at village and tahasil level by the appropriate government agency in order to eradicate and control water borne diseases and ensure safe water supply.
- It is also essential to make villagers 'water literate' to manage their own drinking water resources. Also to make them aware about personal and societal health and hygiene.
