CHAPTER 5
Conclusion

The groundwater collected from 40 different sources are used for drinking purpose and scattered over three Sub-Division of Sonitpur District, Assam was investigated in this work. Sampling and analysis were carried out over a period of two years. From the results, the following conclusion can be made on the quality of ground water in sonitpur district, Assam.

(i) In tube wells, the highest temperatures (28°C) were recorded during pre-monsoon season. The 2nd highest values (27°C) were recorded in three sources of ring well during monsoon season and in ponds of two sources during pre-monsoon season. In case of rivers, the maximum temperature is 26°C and these were found in one source. The highest average values of temperature in ponds were slightly greater than the tube well. From statistical views, for TWs, the distribution is positively skewed in pre-monsoon (A & E) season of both two years i.e. longer tail lie towards the right side or in other words the asymmetric tail extending towards higher value. The other seasons has negatively skewed i.e. longer tail lie towards the right side. In case of kurtosis, it was found that only the distributions in post-monsoon season of the year 2008 have shown positive kurtosis i.e. the curve was leptokurtic i.e. (Sharp distribution). They have greater peakedness than normal curve. The remaining seasons shows negative kurtosis (platykurtic, flat distribution). Here the curves are flatter than the normal curve. In case of ring wells, the pre-monsoon (2008), monsoon (2008 & 2009) and winter (2009) seasons has shows positive skewness and only the post-monsoon (2008) and winter (2009) seasons shows positive kurtosis. Winter (2008) and post-monsoon (2009) seasons shows zero skewness due to equal value of mean and median. In case of ponds, the post monsoon season of both years, winter (2008) and monsoon (2009) has shown positive skewness. Pre-monsoon and winter season of the year 2009 shows positive kurtosis. Monsoon season (2008) and pre-monsoon (2009) seasons shows zero skewness due to equal value of mean and median.
(ii) In Ponds and Rivers water from have pH values within the permissible limit. In tube well and ring well; it was found that most of the sources has pH values which is below the minimum permissible range in some seasons. The most of the water samples in the study area were shifted to acidic in nature. The overall examination of the water samples showed that pH of the water in the study area were all within the safe limit of WHO (6.5-8.5) for drinking water. From statistical study, it was found that for TW, the distribution is positively skewed in pre-monsoon (A & E) and Monsoon (B & F) season of both two years The other two seasons post monsoon (C & G) and winter (E & G) are negatively skewed. In case of kurtosis, it was found that only the distribution in monsoon and winter seasons of the year 2009 has been shown positive kurtosis. The remaining seasons shows negative kurtosis. In case of ring wells, all seasons has been shown positive skewness and only the monsoon season of the year 2008 shows positive kurtosis. Similarly in case of ponds, only the monsoon season of both years shows negative skewness, pre-monsoon and post-monsoon season of the year 2008 shows positive kurtosis along with monsoon season of the year 2009.

(iii) The sources where the iron concentration was found high have objectionable smell.

(iv) During my investigation, the reddish brown colour is observed in some water samples of tube well.

(v) The highest values of chloride for tube well was recorded during pre-monsoon season and lowest were recorded in monsoon season. In case of ring well, the highest and lowest value were found in the winter season. In case of pond, the maximum values of chloride were found during post-monsoon season and lowest value during monsoon season. Similarly the maximum and minimum values of chloride in river were found during winter and pre-monsoon season. From the observations it was revealed that 100% samples of total collection, the chloride concentration were below the desirable limit of WHO guide line value (250mg/l) for drinking water and hence all the drinking water sources were fit for consumption. In case of TW, the distribution is negatively skewed
in winter season of both two years. The other seasons are positively skewed. In case of kurtosis, it was found that the distributions in all seasons of the two year have been shown negative kurtosis. In case of ring well, only the post-monsoon and winter seasons has shown positive skewness and others seasons shows negative skewness. In case of kurtosis, it was found that the distribution in all seasons of the two year shows negative kurtosis. Similarly in case of ponds, the post monsoon and winter season of both two years shows positive skewness. In case of kurtosis, it was found that monsoon and winter seasons of the two years have shown negative kurtosis.

(vi) In the study areas, the concentration of fluoride in some water samples were found below the desirable limit (1.0mg/l) of WHO/BIS and its concentration in some sources found cross the WHO guideline value. The reason of high concentration of fluoride in the study area is that in this area some small tea gardens are present. In tea gardens heavy amount of chemical fertilizers and pesticides are used. These chemicals contain fluoride e.g. fluoride is present as an impurities in normal and triple super phosphate. In case of TW, all the distribution is positively skewed in all seasons during the two years. In case of kurtosis, it was found that the distributions in pre-monsoon and monsoon seasons of the two years shows positive kurtosis In case of ring well, all the seasons has been shown positive skewness. In case of kurtosis, it was found that the distributions in all seasons of the two years found negative kurtosis Similarly in case of ponds, all the distributions has shown positive skewness and positive kurtosis in all seasons.

(vii) The concentrations of sulphate in all water sample of the study area were found below the desirable limit (250mg/l) of W.H.O. The lower concentration of sulphate in the study area is due to the reason that sulphate easily precipitate and settles to the bottom of the sediments of the water sources. From the statistics view, for TW, all the distribution is positively skewed in all seasons. In case of kurtosis, it was found that the distributions in pre-monsoon, monsoon and winter seasons of the two year has shown positive kurtosis. In case of ring well, all seasons has shown positive skewness. In case of kurtosis,
it was found that the distributions in all seasons of the two years shows negative kurtosis. Similarly in case of ponds, all the distributions has shown negative skewness and positive kurtosis in the winter season within two years. The post-monsoon season of the year 2008 has zero value of skewness due to same value of mean and median.

(viii) The concentrations of nitrate in all water sample of the study area were found below the desirable limit (50mg/l) of W.H.O. So the drinking water sources of the study area was said to be safe in terms of nitrate concentration. For TWs, RWs and Ponds, all the distribution is positively skewed in all seasons during the two years. In case of kurtosis, it was found that in case of RW and Pond, the distributions has shown positive kurtosis i.e. the curve is leptokurtic in all seasons within the two years. In case of TW, the negative kurtosis has found in the monsoon season only. The others season shows positive kurtosis.

(ix) The concentrations of turbidity in all water samples were found above the desirable limit (5-10 NTU) of W.H.O. So the drinking water sources of the study area was said to be not safe in terms of turbidity concentration. The high turbidity in ring wells may be due to suspended minerals chalk. In case of tube wells, high turbidity of water may be due to water soluble salts which in contact with air, rapidly oxidize to insoluble salts. The higher concentration of turbidity was found in monsoon season. For TWs, all the distribution is positively skewed in all seasons during the two years. In case of kurtosis, it was found that the distribution has shown both positive and negative kurtosis in some seasons. In case of RWs, the positive skewness has shown in all seasons within two years and positive kurtosis only in winter season (2009). In case of ponds, the positive skewness has shown by monsoon and winter season during the two years and negative one has shown by other two seasons. Similarly, positive kurtosis has shown by pre-monsoon, post-monsoon and winter season.

(x) The concentration of TDS in all water samples were found below the desirable limit (500 mg/l) of W.H.O. So the drinking water sources of the study area was said to be safe in terms of TDS concentration. For TWs, the distribution is
positively skewed in pre-monsoon and winter seasons during the two years. The remaining seasons shows negative skewness. In case of kurtosis, it was found that only the distribution in winter season of the year 2008 shows positive kurtosis. In case of RWs, the positive skewness has shown in monsoon, post-monsoon and winter seasons within two years and only pre-monsoon season shows negative skewness. The positive kurtosis has shown in monsoon season within two years and in winter season of the year 2009. In case of ponds, the negative skewness has shown by monsoon and post-monsoon season and remaining one shows positive skewness. Similarly positive kurtosis has shown by pre-monsoon and monsoon seasons.

(xii) TSS of all the sources has exceeded the limit (5 mg/l, USPHS) and most sources have much high values. For TWs, all the distribution is positively skewed in all seasons during the two years. In case of kurtosis, only the distribution in pre-monsoon season of the two years has shown positive kurtosis. In case of RWs, the positive skewness has shown in pre-monsoon, monsoon and post-monsoon within two years and only winter season shows negative skewness. The negative kurtosis has shown in monsoon season within two years and in post-monsoon season of the year 2008. In case of ponds, all the distribution has shown positive skewness in all seasons within two years. Similarly, negative kurtosis has been shown by winter season only.

The DO contents were higher than W.H.O. maximum value (4 mg/l). For TWs, only the distribution in pre-monsoon season of the two years is positively skewed. In case of kurtosis, it was found that only the distribution in post-monsoon season of the two year has shown positive kurtosis. In case of RWs, the negative skewness has shown in post-monsoon season within two years. The negative kurtosis has shown in winter season of the year 2008 and monsoon season of the year 2009. In case of ponds, the positive skewness has shown by monsoon (within two years) season and winter season of the year (2008). Since in the post monsoon season of the year 2008, the mean and median showed equal value, so skewness was zero.
(xiii) The BOD values were higher in the water of the ring wells, ponds and rivers in comparison to TWs. The monsoon season, BOD levels kept low. All the water samples contain BOD which was below the maximum permissible limit. For TWs, only the distribution in post-monsoon season of the two years is positively skewed. In case of kurtosis, it was found that all the distributions have shown negative kurtosis in all seasons within two year. In case of RWs, the positive skewness has shown in pre-monsoon season within two years and post monsoon season of the year 2009. The negative kurtosis has shown in pre-monsoon season of the year 2009. In case of ponds, the positive skewness shows by all seasons within two years and negative kurtosis shows by monsoon season of the two years and pre-monsoon season of the year 2009.

(xiv) The COD in all samples is in a much higher range, which indicates that oxidizable organic and bioorganic matters are present in excess amount. For TWs, all the distribution is positively skewed in all seasons. In case of kurtosis, the distribution in monsoon season of the two years only shows negative kurtosis. In case of RWs, the positive skewness has shown by all distribution in all seasons. The negative kurtosis has shown in winter season during the two years and monsoon season of the year (2009) In case of ponds, the negative skewness has shown by pre-monsoons seasons only within two years and positive kurtosis has shown by all seasons during the two years.

(xv) The electrical conductance (EC) in all water samples is below than WHO maximum limit and so the ionic content of the ground water samples is not excessive. For TWs, the distribution in winter (2008 & 2009) and monsoon season (2008) has shown negative skewed .In case of kurtosis, the distributions in pre-monsoon season (both 2008 & 2009) and monsoon season (2009) shows positive kurtosis .In case of RWs, the positive skewness has shown by all distribution in all seasons. The positive kurtosis has shown by winter and pre-monsoon seasons during the two years. In case of ponds, the negative skewness has shown by monsoons seasons during the year 2008. The monsoon season has zero skewness due to equal value of mean and median.
Similarly positive kurtosis has shown by post-monsoon and winter seasons during the two years.

The concentrations of Na in all samples were below the desirable limit of W.H.O. For TWs, all the distribution has shown positive skewed. In case of kurtosis, all the distributions shows negative kurtosis. In case of RWs, the negative skewness has shown by post-monsoon seasons during the two years and winter season of the year 2008. The positive kurtosis has shown by pre-monsoon (2008) and monsoon seasons during the year 2009. In case of ponds, the negative skewness has shown by monsoon and post-monsoon season during the year 2008 and positive kurtosis has shown by all distribution in all seasons.

The K concentration in six water samples from TW and five from RW cross the maximum limit. For TWs, all the distribution has shown positive skewed. In case of kurtosis, only the distributions in pre-monsoon season (2009) have shown positive kurtosis. In case of RWs, all the distribution has shown positive skewness and positive kurtosis in all seasons. In case of ponds, the positive skewness has shown by pre-monsoon and post-monsoon season during the year 2008 and 2009, and negative kurtosis has shown by pre-monsoon season during the both year.

All water samples contain Ca which is below the maximum limit. For TWs, only the distribution in pre-monsoon season (2008) has shown positive skewed. In case of kurtosis, it was found that, the distributions in pre-monsoon season (2008), monsoon (2008 & 2009) and post-monsoon season (2009) shows positive kurtosis. In case of RWs, the distribution in monsoon season (2008 & 2009), pre-monsoon and post-monsoon season (2009) has been shown positive skewness. The positive kurtosis has seen only in pre-monsoon season of the year (2009). In case of ponds, the positive skewness has shown by pre-monsoon and winter season during the two year 2008 and 2009 and negative kurtosis has shown by post-monsoon season during the both year.

All water samples contain Mg which below the maximum limit. For TWs, all the distribution has shown positive skewed in all seasons. In case of kurtosis, it
was found that, the distributions in winter season (both year) has shown positive kurtosis. In case of RWs, the distribution in monsoon season (2008 & 2009), post-monsoon (2008 & 2009) and winter season (2009) shows positive skewness. The positive kurtosis has been seen only in post-monsoon season of the year (2008). In case of ponds, the positive skewness has been shown by post-monsoon and winter season during the 2009 and positive kurtosis has been shown by monsoon (2008 & 2009), winter (2008) and post-monsoon season (2009).

All water samples of TW, RW, Pond and Rivers contain Fe which is exceeds the maximum limit. For TWs, all the distribution has been shown positive skewed in all seasons. In case of kurtosis, it was found that, all the distributions have shown positive kurtosis in all seasons. In case of RWs, all the distributions have shown positive skewness in all seasons and similarly negative kurtosis has seen in all distributions. In case of ponds, the negative skewness shows by all distributions and positive kurtosis shows by pre-monsoon season (2008 & 2009), winter season (2008 & 2009) and monsoon season (2009).

The water samples of the study area are free from lead pollution. For TWs, only the distributions in pre-monsoon season (2009) are negatively skewed. In case of kurtosis, it was found that, the distributions in post-monsoon season (2008 & 2009) have shown positive kurtosis. In case of RWs, only the distributions in monsoon season (2009) have shown negative skewness and similarly negative kurtosis has seen in all distributions. In case of ponds, the positive skewness has been shown by post-monsoon and winter season of the two years and negative kurtosis has shown by pre-monsoon season (2008 & 2009) and winter season (2009).

The water samples of the study area are free from copper pollution. For TWs, all the distribution is negatively skewed in all seasons. Similarly in case of kurtosis, all the distributions have shown negative kurtosis in all seasons. In case of RWs also, all the distributions have shown negative skewness and similarly positive kurtosis has seen in all distributions. In case of ponds, the
negative skewness has shown by monsoon season (2008) and winter season of
the two years and negative kurtosis shows by winter season (2008) only.

(xxiii) All water samples contain the Ni concentration which is exceeding W.H.O
maximum limit except the two TWs sources and one RW source. For TWs, the
distribution is positively skewed in winter season of the two year. Similarly in
case of kurtosis, all the distributions have shown positive kurtosis in all
seasons. In case of RWs also, all the distributions have shown negative
skewness and positive kurtosis in all seasons. In case of ponds, the positive
skewness has shown by pre-monsoon season (2008 & 2009) and the
distribution in post-monsoon season of the year 2008 have showed zero
skewness due to same value of mean and median. The positive kurtosis has
shown by monsoon season (2008 & 2009), post-monsoon and winter seasons
of the year (2009).

(xxiv) Some water samples of TWs, RWs and pond contains Cr concentration which
is exceeding the W.H.O. maximum limit. For TWs, the distribution is
negatively skewed in the post-monsoon and winter season of the two years.
Similarly in case of kurtosis, the distribution in the post-monsoon and winter
season of the two year has been shown negative kurtosis. In case of RWs, the
distributions have shown negative skewness and negative kurtosis in winter
season. In case of ponds, the positive skewness has shown by monsoon season
(2008) and all distribution has shown positive kurtosis in all seasons. The
monsoon season of the year 2009 shows zero skewness due to same value of
mean and median.

(xxv) Some water samples of TWs and RWs contains As concentration which were
very high value and cross the WHO maximum value. For TWs, the
distribution is positively skewed in the all seasons of the two year. Similarly in
case of kurtosis, all the distribution has shown negative kurtosis. In case of
RWs, all distributions have shown positive skewness and positive kurtosis. In
case of ponds, all distribution shows positive skewness and negative kurtosis.

(xxvi) All the water samples of the study area contain Zn concentration which is
below the WHO maximum limit. For TWs, the distribution is negatively
skewed in the all seasons of the two year. Similarly in case of kurtosis, it was found that, all the distribution has shown negative kurtosis. In case of RWs, all distributions have shown positive skewness and negative kurtosis has shown by pre-monsoon season (2008) only. In case of ponds, all distribution shows positive kurtosis and negative skewness during all seasons.

**SUGGESTIONS:**

Overall, the water quality of the ground water sources of this district could not be termed as completely satisfactory. This study of water quality in this area will help the concern government authority to adopt proper policy for improving water quality in future which will be benefit for a large section of the society. In order to reduce the contamination of ground water sources, the sources should be properly treated. It should avoid over fertilization in the agricultures. The farmers should be encouraged to use bio-fertilizer and bio-pesticides to avoid the groundwater contamination. Lime or bleaching powder should be used periodically. Cost-effective, user friendly technologies providing pure water are required to counter the serious health hazards due to consumption contaminated water. A holistic approach involving medical practitioners, scientists and social workers must be needed to work coherently to find out a solution for safe drinking water. Awareness and training programmed should conducted by NGO’s and social organizations for the sustainable use and management of ground water of this region. a short and long term management action plan should be taken by the concern authority for the efficient use of ground water resources because water is positively correlated with health.