Abstract

The groundwater pollution may take time depending upon the concentration of pollutants and geological structure. However, once it is polluted it shows hazardous effects and most importantly there is hardly any reversal or remedial measures. It can be quite relevant study to understand the sources of groundwater pollution and degree of intensity of pollution. It has direct bearing on sustainability of livelihood of people especially poor section of society. The present study is an attempt to reveal such issues. For this, Shirur taluka of district Pune has been selected. The study has adopted microbial approach to understand the intricacies of the issue. In this sense it has academic as well as social relevance. The groundwater resource in Shirur area has been fragile because of two reasons. First, the recharging process is hindered due to rapid industrialization and urbanization. The non-percolating areas are increasing with phenomenal growth of the area. Secondly, the groundwater storage is also exposed to pollution by heavy consumption of chemical fertilizers, industrial effluents and domestic sewage. People of the area are wholly dependent on groundwater as it is the only source of drinking water for them. However, the resource is being depleted due to environmental threats like reduction in percolation, pollution and non-sustainable use. With this background, an assessment of groundwater quality in Shirur taluka, Pune district, Maharashtra was undertaken. The present study was aimed to focus on the contamination of groundwater of study area at different locations during the period December 2009 to May 2011.

The work was carried out under the following lines:
1. Physico-chemical analysis of groundwater using standard procedures as per APHA (2005)
2. Analysis of heavy metals Fe, Mn, Ni, Zn, Cu, Cd, Pb, F⁻ and Mo in water
3. Interpretation of the results of groundwater analysis using GIS tools and techniques
4. Evaluation of drinking and irrigation water quality

The present thesis is divided into six chapters.
The first chapter introduces India’s water disparity, water quality as principle determinant of health, groundwater quality and its contamination, impact of urbanization on groundwater quality, application of GIS in groundwater quality monitoring and major groundwater problems in Pune district are mentioned. The scope of the study, aims and objectives are specified.

The second chapter focuses on the characteristics of Shirur taluka as the study area. The study area is situated in the Pune district of Maharashtra state, India. Systematic location, drainage pattern, geology of the area and thorough information of the study area is incorporated in this chapter.

The third chapter deals with a detailed literature review based on physico-chemical assessment of groundwater, factors deciding the water quality and sources of pollutants and heavy metals. Literature review was done considering the work at national and global level. From the literature review, it is concluded that there is a need of monitoring of groundwater quality, generation and interpretation of data and compare the changes in water quality with time. It may be remarked here that there is no duplication of any previous work in the present study.

The fourth chapter highlights on the materials and methods used for the assessment of groundwater quality. The study was carried out with the help of three major components: input from topographic sheets, data available from GSDA and data collected during field visits. Field visits were carried out in the months of December, 2009 and December, 2010 for the post-monsoon period and during May, 2010 and May, 2011 for the pre-monsoon period. The fieldwork included collection of water samples from dug wells and bore wells. Techniques and methods followed for collection, preservation, analyses and interpretation of water samples are those given by standard methods (APHA 1995). GPS was used for location of sampling sites along with topographic maps. A total of one hundred twenty four dugwell and borewell water samples were collected. Each of the groundwater samples were analyzed for electrical conductivity (EC), pH, total hardness (TH), total dissolved solids (TDS) and major cations (K⁺, Na⁺, Mg²⁺, Ca²⁺) and anions (F⁻, PO₄³⁻, SO₄²⁻, Cl⁻, HCO₃⁻) by using the standard methods given by APHA, (2005). Heavy metal analysis such as Cu, Zn,
Fe, Mn, Ni, Cd, Mo, Pb and F⁻ was carried out by AAS (Atomic Absorption Spectroscopy). Observation well data from 1990 to 2009 were collected from GSDA, Pune. Followed by water quality analysis, spatial analysis, and query analysis were carried out for water quality mapping in the study area using GIS as a tool. Results and discussion of the generated data is included in the fifth chapter. With the help of literature the results are interpreted and discussed. Physico-chemical analyses of groundwater revealed that for most of the groundwater samples pH was more than 7.0 but well within the permissible limits. Further, the spatio-temporal variations of EC values indicated that conductivity of the area is increasing with the passage of time because of the addition of domestic, agricultural and other effluents to the groundwater. Besides, pre-monsoon season showed higher values of conductivity which could be due to higher water-rock interaction and subsequent higher leaching in summer. TDS and TH values, in most of the samples exceeded the permissible limits shows unsuitability of groundwater for drinking and irrigation purposes and their very high values can be attributed to the addition of effluent flowing from the construction sites and domestic sewage disposals in newly urban areas. The results showed that magnesium is exceeding the permissible limit in majority of the samples in all seasons. While calcium is within the permissible limits in pre-monsoon seasons but more than 50% samples are exceeding the permissible limit in post-monsoon seasons. The higher concentration of Ca and Mg are indicative of the anthropogenic sources. Bicarbonates were persistently high during post-monsoon period indicating the contribution from carbonate weathering process. Although the concentration of sodium was slightly high in few samples in all seasons which gets accumulated in groundwater as a result of cation exchange process. The abnormal concentration of potassium at few places is due to urban pollution and fertilizer leaching. Higher concentration of chloride in some samples in post-monsoon period confirms the anthropogenic sources at those stations. The spatio-temporal variations of SO₄, PO₄ and NO₃ show meager changes i.e. they almost maintain their concentration within the permissible limits in groundwater of study area system except few stations exceeding the limits which can be due to anthropogenic activity. Trace element geochemistry of
groundwater exhibits anthropogenic inputs and basaltic origin of ions. The higher concentration of Pb and Cd indicates influence of anthropogenic activities in the area while as higher values of Mo are due to its derivation from weathering of feldspars in basaltic aquifer and severe anthropogenic influence in the groundwater of study area. The major ionic data plotted on piper Trilinear Diagram indicated that hydrochemical facies occurring in the study area are scattered in the Ca+Mg–HCO₃+CO₃ dominant water type in post-monsoon period as the dissolution of primary silicates due to process of chemical weathering. While Ca+Mg–HCO₃+CO₃ and Na+K–HCO₃+CO₃ major water facies develops during pre-monsoon seasons. The suitability of groundwater for irrigation use was evaluated by calculating Sodium absorption ratio (SAR). In the present study all the groundwater samples have shown SAR values less than 10. The groundwater from study area can thus be graded as excellent for irrigation use. Graphical representation of the chemical data on the irrigation suitability diagram shows that major high salinity–low sodium and high salinity–medium sodium waters are present which need adequate drainage to overcome the salinity problem. Gibb’s diagram showed that majority of the samples fall in the rock dominance area indicating the interaction between rock chemistry and the chemistry of the percolating waters in the subsurface. However, the study area also experiences the evaporation as well as precipitation dominance as evidenced by some samples falling in the evaporation dominant area. This is directly dependent on rainfall. Good correlation of EC with Cl and Ca and TH with Mg and Cl and Cl with Ca and Na indicates that most of the ions are involved in various physiochemical reactions, such as oxidation–reduction and ion exchange in the groundwater aquifer system and anthropogenic input in groundwater. Cursory examination of the data reveals that majority of the groundwater samples in the study area were dominated by Mg hardness as compared to Ca hardness. In case of trace elemental correlation the area showed anthropogenic sources such as Cd – Ni – Pb battery works. Comparisons of data with the water quality standards prescribed by WHO (2008) and BIS (2001) and quality maps prepared by Query analysis in GIS indicates that the groundwater in the study area is not suitable for drinking purposes. The nine year data of groundwater
quality (2001 to 2009) procured from GSDA, Pune was used to correlate the yearly hydrogeochemical data with the present study in order to generate a database on groundwater and finally prepare a groundwater quality map by Query analysis in GIS for entire Shirur taluka.

Chapter sixth gives total essence of thesis in brief as well as important conclusions emanating from the present study and valuable suggestions to reduce the further degradation of groundwater quality in Shirur taluka.

This comparative study reveals the need of proper management of groundwater resource, monitoring of groundwater quality periodically and comparison of the results which would help to undertake corrective measures to manage groundwater resource.