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# Ground Water Suitability for Drinking in Dindigul Block of Dindigul District,Tamil Nadu, India

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## Abstract

*Ground water is one of the major sources of water in arid and semiarid regions. Assessment and mapping of ground water quality is very important because the physic- chemical characteristics of groundwater determine its suitability for drinking purpose. The present study evaluates the suitability of groundwater for drinking purpose in the study area coupled with GIS technology. 18 water samples were collected and analyzed for various physiochemical constituents. The integrated drinking water quality map prepared shows the areas good, suitable and unsuitable for drinking purposes.*

**Keywords:** Groundwater Quality, Spatial integration, GIS technology, physiochemical parameters.

## Introduction

All life on the earth surface depends on water for their basic requirements. The ever increasing development in all the sectors like industrial, agricultural and urban is increasing the contamination of water resources system. Pollutants are accumulated in ground water and soil due to the processes of continuous discharge of industrial, agricultural and domestic effluents[1]. Due to tremendous development of industry and agriculture, the water ecosystem has become perceptibly altered in several respects in recent years and as such they are exposed to all local disturbances regardless of where they occur. The increasing industrialization, urbanization and developmental activities, to cope up the population explosion have brought inevitable water crises[2]. The developing countries like India groundwater is the major source of drinking water. In arid and semiarid regions ground water plays an important role in the development and the public health of the population. The estimation showed that ground water is the source of drinking for one third of the world population. The suitability of ground water for drinking purpose is determined by its quality[3]. The concentrations of various chemical constituents determine the quality of ground water which is mostly derived from the geological data of the particular region. The weathered portion along with joints and fractures in the rocks are the store house of ground water. The surface and ground water is polluted by the discharge of solid and liquid industrial and municipal waste. The presence of heavy metals in excess rendered the available water non potable in many parts of the country[4]. Dindigul is one of the important places for its tannery units. It has more than 80 registered tannery units and lot of unregistered small tannery units. It is the fact that the processing of leather requires huge amount of freshwater along with various chemicals. Ground water is the main source of drinking water in the study area. Dindigul Block is located between $77^0$ 45'' and $78^0$ 4' 30'' East longitude and $10^0$ 14'45'' and $10^0$ 31' 00'' North latitudes and covers an geographical area of 409 sqkms. Geologically the area is covered by hornblende gneiss, quartzite, composite gneiss and charnokites. Geomorphologically Dindigul Block comprises of buried pediplain with buried, shallow and deep pediments. The low relief of the study area is identified by occupation of buried pediments in most of the area. In the study area groundwater is the major source of potable water, which is utilized for domestic, agricultural and industrial purposes. The movement and storage of ground water is facilitating in the weathered zones through a network of joints, faults and lineaments. Wells, bore wells and dug cum bore wells are used to extract ground water in the study area. The shallow aquifer gets both direct recharge from rainfall and indirect recharge as seepage. The ground water in the study area is deteriorated by over exploration, excessive agricultural practices, and discharge of untreated domestic as well as industrial effluents. No perennial streams exist in the area. The study area receives an average rainfall of 1400 mm in 2013. Porous and friable irugur soil series covers about 60 % of the study area. Hence the present study aims to evaluate the suitability of groundwater for drinking purposes[5].

## Material and Methods

Eighteen ground water samples were randomly collected from the observation wells and analyzed for various physiochemical constituents. 500 ml polythene bottles were cleaned and rinsed thoroughly with sample water and used for sample collection. The samples were analyzed for major physiochemical constituents such as pH, Electrical conductivity (EC), Total Dissolved Solids (TDS), Calcium (Ca) Magnesium (Mg), Sodium Na), Chloride (Cl) and Total Hardness (TH) (table-1) and compared with WHO standard for drinking purpose[6]. The spatial distribution maps for selected parameters were prepared by integration of spatial and attribute data in GIS platform. Finally the drinking water quality map was prepared by integrating the thematic grid maps of Chloride, TDS and TH in Arc info grid addition. The map delineated the study area into three groups namely the areas where the groundwater is good for drinking, suitable for drinking and unsuitable for drinking[7].

**Table-1**
**Hydro geochemical Data of Dindigul Block**

| S. No | Sample locations | EC | pH | Ca | Mg | Na | K | $NO_3$ | TDS | TH | SO4 | CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Thamaraipadi | 1131 | 7.1 | 52 | 34 | 102 | 18 | 9 | 769 | 270 | 50 | 170 |
| 02 | Mullipadi | 3034 | 7.4 | 112 | 106 | 248 | 102 | 26 | 2063 | 720 | 96 | 800 |
| 03 | Kovilur | 823 | 6.6 | 48 | 26 | 60 | 14 | 8 | 560 | 230 | 45 | 120 |
| 04 | Periyakottai | 1325 | 6.8 | 76 | 41 | 120 | 18 | 9 | 901 | 360 | 52 | 100 |
| 05 | Balakrishnapuram | 2582 | 7.1 | 80 | 31 | 344 | 76 | 22 | 1756 | 330 | 105 | 525 |
| 06 | Thadicombu | 1605 | 7.3 | 88 | 48 | 140 | 22 | 13 | 1091 | 420 | 83 | 315 |
| 07 | Agaram | 2951 | 7.2 | 92 | 101 | 272 | 102 | 26 | 2007 | 650 | 135 | 675 |
| 08 | A.Vellodu | 1128 | 8.1 | 52 | 26 | 124 | 18 | 9 | 767 | 240 | 23 | 150 |
| 09 | Pallapatti | 15089 | 6.9 | 640 | 456 | 1950 | 188 | 48 | 10260 | 3500 | 43 | 4800 |
| 10 | Kurumbapatti | 936 | 7.8 | 48 | 36 | 72 | 5 | 9 | 636 | 270 | 43 | 120 |
| 11 | Chettinayakanpatti | 2213 | 7.6 | 84 | 46 | 284 | 76 | 22 | 1505 | 400 | 95 | 550 |
| 12 | Seelapadi | 6597 | 7.0 | 268 | 151 | 710 | 160 | 37 | 4486 | 1300 | 153 | 1800 |
| 13 | Dindigul Town | 1537 | 7.2 | 80 | 43 | 136 | 22 | 13 | 1045 | 380 | 80 | 190 |
| 14 | Adiyanuthu | 1493 | 6.7 | 84 | 46 | 120 | 22 | 13 | 1015 | 400 | 80 | 280 |
| 15 | Sirumalai | 757 | 7.8 | 52 | 29 | 60 | 14 | 8 | 515 | 250 | 41 | 65 |
| 16 | Tottanuthu | 1382 | 7.1 | 76 | 41 | 120 | 18 | 9 | 940 | 360 | 75 | 265 |
| 17 | Algauvarpatti | 2158 | 7.4 | 60 | 31 | 344 | 76 | 22 | 1467 | 280 | 73 | 410 |
| 18 | Anaipatti | 911 | 7.2 | 64 | 34 | 72 | 5 | 9 | 620 | 300 | 54 | 130 |

Units for EC is micromhoms/cm and all others are in mg/l

## Results and Discussion

GIS is used to evaluate the quality of groundwater in Dindigul block. Spatial variation maps of major groundwater quality parameters like TDS, total hardness and chloride were prepared. The existing groundwater condition of the study area was assessed by the spatially integrated groundwater quality map prepared using Arc GIS software. Based on these maps the integrated water quality map of Dindigul block was prepared to know the existing groundwater condition of the study area[7]. Table-2 shows the most desirable limits and maximum allowable limits of various water quality parameters in the study area prescribed by World Health Organization.

**pH Ion Concentration:** The pH value of the groundwater samples in the study area ranging from 7.1 to 8.1. The pH value of less than 7 was found in 4 water sample locations. Sample number 8 shows the maximum pH value of 8.1 in the study area. In all other sample locations the value of pH is fluctuating above 7 and below 8**[8].**

**Electrical Conductivity (EC):** Electrical conductivity is an index of the amount of minerals present in the water and it varies with temperature. The electrical conductance is a good indication of total dissolved solids which is a measure of salinity that affects the taste of potable water. Depending on the conductivity water can be classified by excellent, good, permissible, brackish and saline. A classification on this basis is given in table-3. There is no water sample comes under excellent ad good class, four samples fall in the permissible category. Five well locations have brackish water and remaining nine sample locations have saline water[10].

**Total Dissolved Solids (TDS):** The ground water for any purpose is classified depending upon the properties of total dissolved solids. The presence of chemical constituents such as carbonates, bicarbonates, chlorides , phosphates, nitrates of calcium, magnesium, sodium, potassium salt and others particles determine the properties of TDS in ground water. According to WHO standard for drinking water quality 1000 mg/l is the permissible value of TDS. In this study area 8 water samples shows less than 1000 mg/l of TDS. In all the remaining 10 sample locations the TDS value is beyond the permissible limit and unsuitable for drinking. Figure-1 shows the areas suitable for drinking based on TDS[11].

**Table-2**
**Comparison of physiochemical constituents of the groundwater sample with WHO standards for Drinking purpose[8]**

| Physio Chemical constituents | WHO International Standard for Drinking Purpose | | Sample exceeding Maximum allowable limit |
|---|---|---|---|
| | Most Desirable Limit | Max allowable Limit | |
| EC /cm | 1000 | 1500 | 2,5,6,7,9,11,12,13, 17 |
| TDS (mg/l) | 500 | 100 | 2,5,6,7,9,11,12,13, 14,17 |
| TH ( mg/L) | 100 | 500 | 2,6,7,9,12, |
| Na ( mg/l) | - | 200 | 2,5,7,9,11,12,17 |
| Ca (mg/l) | 75 | 200 | 9,12 |
| Cl (mg/l) | 200 | 600 | 2,7,9,12 |
| Mg (mg/l) | 50 | 150 | 9,12 |
| SO4 (mg/l) | 200 | 400 | - |
| NO3 (mg/l) | 45 | - | 9 |

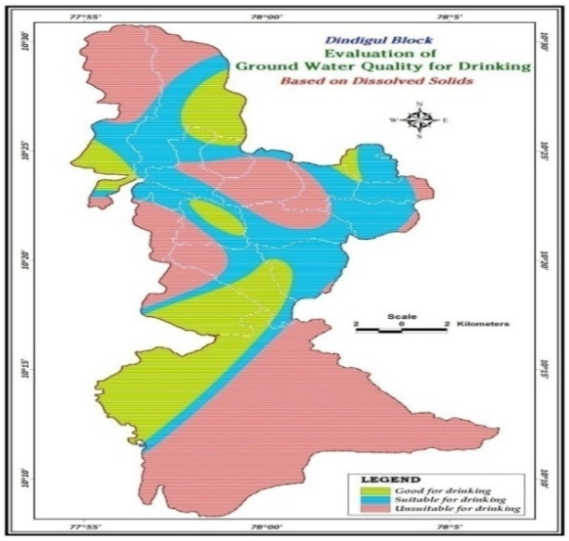
**Table-3**
**Classification of samples according to Electrical Conductivity [8]**

| EC in micromhos/ cm at 25 C | Quality of water | Sample numbers | Total samples |
|---|---|---|---|
| 0-333 | Excellent | - | - |
| 333-500 | Good | - | - |
| 500-1000 | Permissible | 3,10,15,18 | 4 |
| 1000-1500 | Brackish | 1,4,8,14,16 | 5 |
| 1500-10000 | Saline | 2,5,6,7,9,11,12,13, 17 | 9 |

**Table-4**
**Characteristics of Ground water based on TDS[8].**

| TDS (mg/l) | Characteristics of Water | Sample Locations | Total No. of sample |
|---|---|---|---|
| <1000 | Fresh water | 1,3,4,8,10,15,16,18 | 8 |
| 1000-10000 | Brackish water | 2,5,6,7,11,12,13,14, 17 | 9 |
| 10000-100000 | Saline water | 9 | 1 |
| >100000 | Brine Water | Nil | Nil |

**Total Hardness:** The presence of calcium and magnesium in groundwater determine the hardness of the water. In the study area majority of water sample fall in hard water category based on TH values. According to WHO international standard the maximum allowable limit of TH for drinking purpose is 500 mg/l and most desirable limit is 100 mg/l. The grading result shows that no water sample comes under soft and moderately hard category. About six sample falls in the category of hard water and the remaining 12 samples comes under very hard class. The spatial distribution map of hardness shows areas suitable and unsuitable for drinking purpose[12].

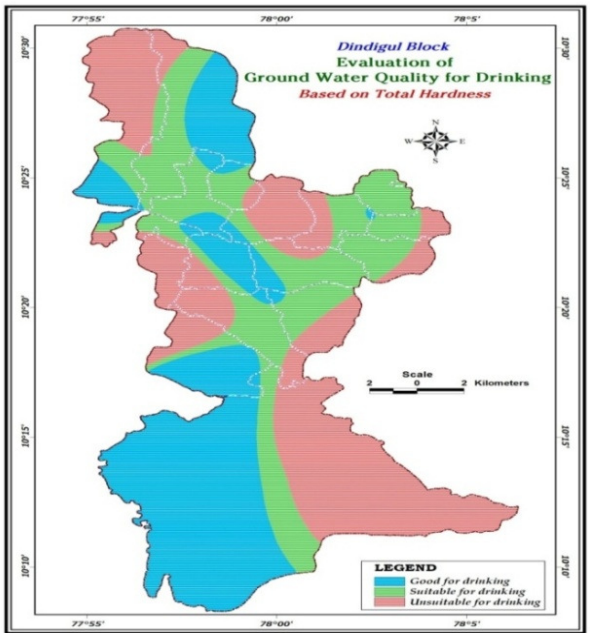



**Figure–1**
**Groundwater Quality for Drinking Purpose Based on Total Dissolved Solids**

**Chloride:** High concentration of chloride produces salty taste in drinking water and thus becomes objectionable for drinking. The permissible limit for Chloride in groundwater for drinking purpose is 250 mg/l. based on World Health Organization. It can be seen from the table-1 that the concentration of Chloride is beyond the permissible limit for drinking in 10 sample locations. The concentration of Chloride ranged from 65 mg/l to 4800mg/l in the study area. The spatial map shows the area suitable for drinking based of chloride concentration[5].

**Table 5**
**Characteristics of Ground water based on TH[8]**

| Total Hardness | Water Class | Sample Locations | Total Samples |
|---|---|---|---|
| <75 | Soft | Nil | Nil |
| 75-150 | Moderately hard | Nil | Nil |
| 150-300 | Hard | 1,3,8,10,15,17 | 6 |
| >300 | Very Hard | 2,4,5,6,7,9,11,12,13, 14,16,18 | 12 |

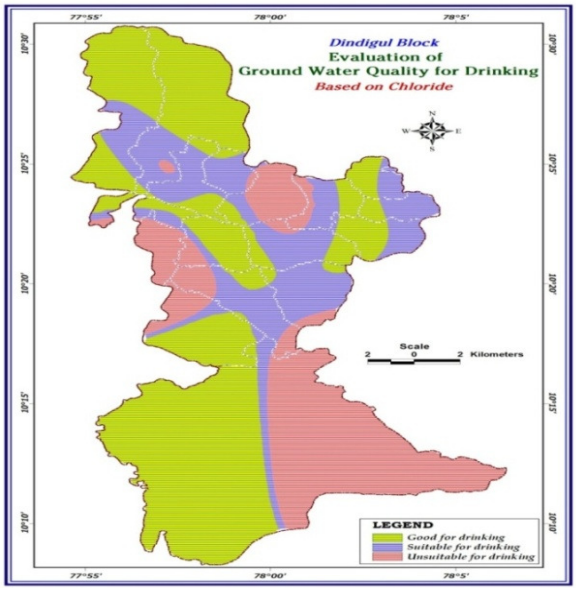



**Figure–2**
**Groundwater Quality for Drinking Purpose Based on Total Hardness**

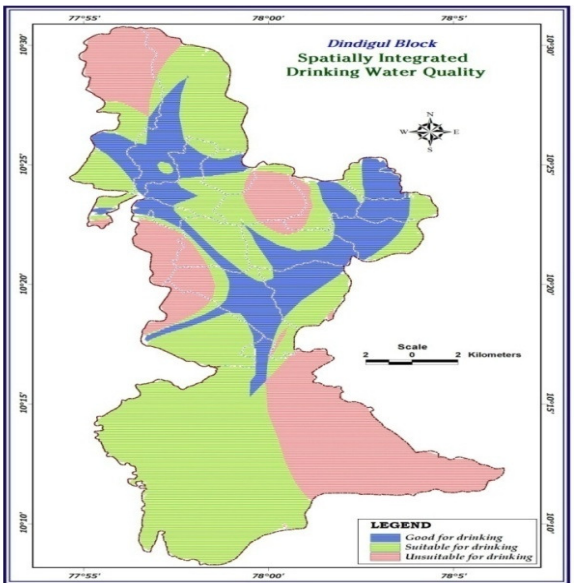
**Integrated Ground water Quality Map for drinking purpose**
The integrated drinking water quality map was prepared by spatially integrating the grid maps of TDS, TH and Chloride for drinking purposes (figure-4) This map also delineated the area into three groups namely good for drinking, suitable for drinking and unsuitable for drinking. The map also indicates that 1/5 of the area comes under good for drinking category. In 2/5 of the area the ground water is suitable water for drinking purpose and in the remaining areas the groundwater is is unsuitable for drinking purposes[13].

## Conclusion

The suitability of groundwater for drinking purpose in Dindigul Block is assessed by its physiochemical constituents present in the groundwater samples.




**Figure–3**
**Groundwater Quality for Drinking Purpose Based on Chloride**




**Figure–4**
**Integrated Drinking Water Quality map for drinking Purpose**

The GIS software was used for preparation of various thematic maps and integrated groundwater quality map. The analysis reveals that, pH value range from 7.1 to 8.1. Based on EC in 78 % of the groundwater samples in the study area is not suitable for drinking purposes. About 50 % of the water sample comes under brackish water based on TDS. The spatial distribution map all the sample locations shows hard and very hard water class in the respect of TH. The chloride concentration exceeds the permissible limit in ten sample locations. The integrated groundwater quality map also indicates that 1/5 of the area comes under good for drinking category. In 2/5 of the area the ground water is suitable water for drinking purpose and in the remaining areas the groundwater is unsuitable for drinking purposes[13].

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