

## ESTABLISHMENT OF WATER QUALITY INDEX IN DIFFERENT WATERS OF THENI AND DINDIGUL DISTRICTS

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### ABSTRACT

Water Quality Index is one of the most powerful and effective tool for analyzing the overall characteristics of water quality and monitor water pollution in any areas and transfers information exactly on water quality trends to policy makers and to the general public. Water quality indices are useful for concise information in order to achieve a national perspective. Objective of this study was to evaluate and determine water quality index of Theni and Dindigul districts, Tamilnadu. A total of 79 samples were analysed using a weighed arithmetic index method to represent a clear scenario about the quality of water for drinking purposes. The indices have been computed for 2006-2015. This study also identifies the critical condition of water that affects the groundwater quality. It was found that the water quality ranges between excellent and unsuitable for drinking. The unsuitable river, dam, pond and bore well water needs to be treated before drinking.

**KEY WORDS :** Water Quality Index, Theni, Physico-chemical parameters, Drinking water and quality.

### INTRODUCTION

From the beginning of human civilization people have settled close to water sources such as rivers, lakes and springs (Annadurai and Shanmugam, 2000). The earth's hydrosphere contains a high amount of water but 97.5% of this is saline water and 2.5% is fresh water. Water plays a vital role for the existence of all living forms and essential for all the activities of human beings and is the basic right (WHO, 2011). Water quality indices (WQI) are tools to determine conditions of water quality and globally accepted format with its valuable rating to portray the overall water quality for the assessment and selection of appropriate treatment technique to understand its consumption and irrigation purposes (Tyagi *et al.* 2013). WQI embodies the chemical, physical and biological parameters to concise into a

numerical, simple number that can be easily understood, communicated to the common people and management authorities (Brown *et al.*, 1970; Abbasi and Abbasi, 2012). Indices are based on the comparison of the water quality parameters to regulatory standards and give a single value to the water quality of a source (Khan *et al.*, 2003; Abbasi 2002). Many WQ indices have been used for water resources (Cude, 2001; Abbasi and Abbasi, 2012; Singh and Kamal, 2014; Gitau *et al.*, 2016; Sim and Tai, 2018) including multi criteria approach (Chimankpam *et al.*, 2019). In Tamilnadu, ground water in many areas is not suitable for domestic usage, irrigation and recently a few researchers tried to use WQI method for giving WQ rating in Tamilnadu (Latha *et al.*, 2002; Palanisamy *et al.*, 2007, Maheswari and Sankar, 2011). In Theni district, the WQI was not made so far hence it is an effort made

to analyse the river, pond, bore well and dam or reservoir water of Theni district, Tamilnadu to clearly state the status of Theni water.

**MATERIALS AND METHOD**

**Study area**

Theni lies at the foot of Western Ghats. Periyakulam which is located between 10.07'N and 77.33'E in Theni district. It has an average elevation of 282 meters (925 feet). It is located at the foot hills of the Western Ghats bordering the neighbouring State of Kerala (Figure 1). Samples were collected from various sources such as rivers, pond, dam reservoir and bore wells. They were preserved for analysis of physico-chemical parameters following American Public Health Association (APHA, 2005). The areas covered for analysis includes Periyakulam, Bodi, Aundipatty, Uthamapalayam, Sothuparai, Vaigai, Ambasamuthram, Muthulapuram, Ramasamaynayakkanpatti, Thirumalapuram, Anamalayanpatti, Cumbam, Hanumanthanpatti, Vadugapatti, Dharumathupatti, Surulipatti, Anaikaraiyapatti, Ramanathapuram, Durairajapuram, Melachokanathapuram, Uppukottai, Melmangalam, Dombuchery and Thamaraiikulam in Theni district and Maruthanathi, Manjalar, Tannery Effluent Pond, Bharathipuram, Devasegamanipuram, Arockiamatha Street, Xavier street, NSNagar, Ponthamarai, Pulianatham, Pannaipatti and Vinayagar colony in Dindigul district (Figure 1).

**Physico-chemical analysis of water**

Water samples from different sources were identified and collected after running them for 15 minutes. A total of 79 samples from Theni (64) and

Dindigul districts (15) were collected during 2006-2015. The water samples collected from various sources such as river, pond, bore well, open well and dam or reservoir were subjected to various physico-chemical analysis such as pH which was determined with the help of the pH meter, Electrical conductivity, Total Dissolved Solids (TDS), Total Alkalinity (TA), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (P), Iron (Fe), Ammonia (NH<sub>3</sub>), Nitrite (NO<sub>2</sub>), Nitrate (NO<sub>3</sub>), Chloride (Cl), Fluoride (F), Tidy's test by the following APHA (2005) method during 2006-2015 for drinking water quality standards.

**Water Quality Index (WQI):** Water quality index is defined as a method of rating that gives the composite influence of individual water quality parameters on the overall quality of water for human consumption (Al-Mohammed and Mutasher, 2013). Water quality index was measured by using the following equation for WQI as used by Amadi *et al.*, (2017). This method was developed by Brown *et al.*, (1972) and used by many scientists (Chowdhury *et al.*, 2012; Tyagi *et al.*, 2013). To know the water quality rating and status of the study area, the quality rating developed by Krishnan *et al.*, 1995 was used. Overall water Quality Index was calculated by aggregating quality rating with the unit weight as shown below

$$WQI = \sum W_i * q_i$$

Where q<sub>i</sub> is quality rating scale for each parameter

$$q_i = (C_i/S_i) * 100$$

C<sub>i</sub> is mean concentration of parameters

S<sub>i</sub> is the Indian Standard for Drinking Water Quality (BIS, 2012)

Relative Weight (W<sub>i</sub>) is calculated by a value

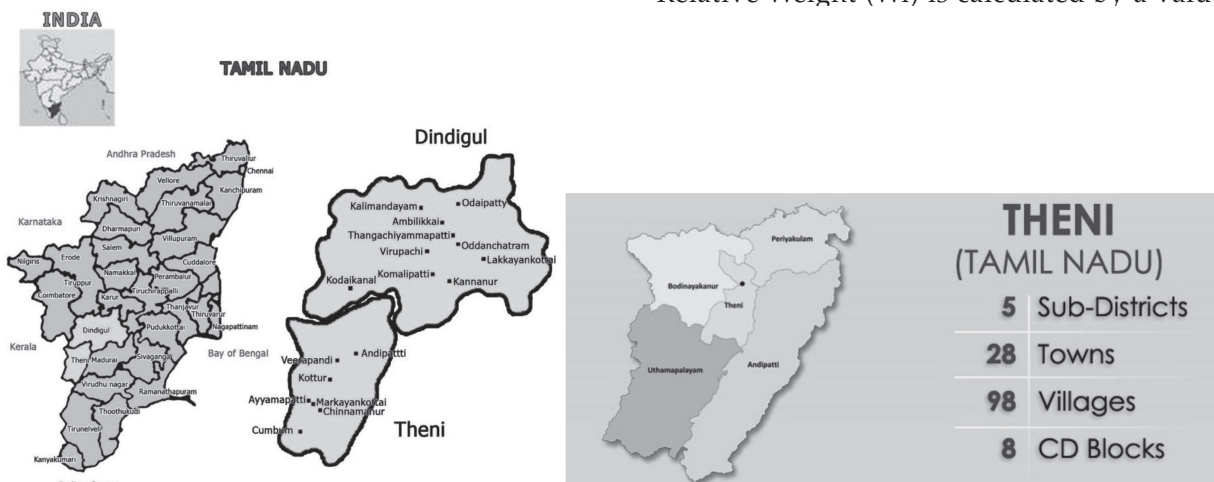


Fig. 1. Map of Theni and Dindigul in Tamilnadu, India.

**Table 1.** Relative weight of physico-chemical parameters used for analysis with BIS (2012) and weight based on Central Ground Water Board (CGWB-2008).

Parameters	Weight	Relative Weight	Indian Standard Value
pH	4	0.074074074	6.5
Total Dissolved Solids	4	0.074074074	500
Alkalinity	4	0.074074074	20
Total Hardness	3	0.055555556	200
Calcium	2	0.037037037	75
Megnesium	2	0.037037037	30
Sodium	4	0.074074074	200
Potassium	1	0.018518519	12
Iron	4	0.074074074	0.3
Ammonia	3	0.055555556	1.2
Nitrate	4	0.074074074	45
Chloride	5	0.092592593	250
Fluoride	5	0.092592593	1
Sulphate	4	0.074074074	150
Tidy's test O <sub>2</sub>	5	0.092592593	244
	Total	54	1

inversely proportional to standard value (Si) of each respective parameter that is  $W = 1/Si$ .

For computing WQI, the sub index (SI) is first determined for each chemical parameter, as given below:  $SI_i = W_i \times q_i$

$$WQI = \frac{\sum SI_i}{n}$$

Where,

SI<sub>i</sub> - the sub index of ith parameter

W<sub>i</sub> - relative weight of ith parameter

q<sub>i</sub> - the rating based on concentration of ith parameter, and

n - the number of chemical parameters.

WQI values were classified into 5 categories; the water quality is rated as excellent, good, poor, very poor and unsuitable for drinking when the value of the index lies between 0–50, 50–100, 100–200, 200–300 and >300, respectively (Table 2).

## RESULTS

Water from surface, ground, bore well has been analysed and the physico-chemical parameters were subjected to WQI analysis. The result was compared

**Table 2.** Water quality rating as per weight arithmetic water quality index method.

WQI value	Rating of water Quality	Grade
0-50	Excellent	A
50-100	Good	B
100-200	Poor	C
200-300	Very Poor	D
>300	Unsuitable for drinking purpose	E

Status/grade of water quality (Krishnan *et al.*, 1995)

with the water quality rating to find out the status of their respective WQI value. River of Periyakulam water, Uthamapalayam River, different points in Periyakulam such as Aadupaalam, Periyakoil, Theerthathotti, Bodi, Aundipatty, Uthamapalayam, Sothuparai Dam, Sothuparai away from dam, Vaigai, Muthulapuram, Ramasamynayakkanpatty and Thirumalapuram were excellent water (Table 3).

River water from Periyakulam, Bodi, Surulipatty, Aundipatty, Periyakoil and Uthamapalayam, Ambasamuthram, Muthulapuram, Ramasamaynayakkanpatti, Thirumalapuram, Anamalayanpatti, dam water from Sothuparai, Vaigai, Vaigai Dam Near the bridge, Vaigai Dam North, pond water of Ambasamuthram and Muthulapuram were good water in Theni district (Table 4).

River water from Bodi, Aadupaalam, Theerthathotti, Anamalayanpatti, Cumbam, Hanumanthanpatti, Veerapandi, dam water from Sothuparai, Vaigai Dam Center, Vaigai Dam South and Vaigai, Vadugapatti pond water, bore well water of Bodi Pudur, Dharmathupatti, Renganathapuram, Uppukottai, Chinnakadai street and Melmangalam east street showed poor water in Theni district (Table 5).

Bore well water of Periyakulam, Thamaraiikulam, Vadugapatti Union office st. and Thamaraiikulam VOC st. showed unsuitable water in Theni district (Table 7).

Water from river, dam, bore well, open bore well and pond were collected for analysis of physico-chemical parameters and quality of water was

presented using WQI (Table 8). River water from Maruthanathi was excellent for drinking purpose during 2014, while in 2015 it became poor due to erosion of waste into river which makes it to the increase of pH, TDS, alkalinity, hardness and iron. Dam water from Manjalar was good in 2007 but became very poor in 2014. Bore well water of Bharathipuram, Arockiamatha Street, Xavier Street, Devasegamanipuram, Ponthamarai were very poor in condition, while East Arockiamatha st., NSNagar and Pulianatham in Dindigul were unsuitable for drinking without treatment (Table 8). Open bore well water of Pannaipatti and Vinayagar colony showed unsuitable for drinking including pond water of Tannery Effluent in Dindigul district (Table 8) which is highly polluted.

### DISCUSSION

In Theni district, Periyakulam showed the lowest

WQI that represents the water of Periyakulam is excellent for drinking purpose than Uthamapalayam river water and other places during 2006. On comparing Muthulapuram and Ramasamaynayakkanpatti, Muthulapuram water was better than Ramasamaynayakkanpatti water may be due to increase of TDS, alkalinity, total hardness and iron. Sothuparai and Periyakulam showed high excellent water. Sothuparai WQI was lesser than Vaigai during 2012 indicates Sothuparai water is better than Vaigai water. Thirumalapuram bore well water was excellent to drink as in the study of Mohamed Ali *et al.* (2016).

Table 4 illustrates Bodi, Surulipatty, Sothuparai, Periyakulam and Aundipatty river water was good and potable. WQI was high in Uthamapalayam among the rivers while among the dam water Vaigai showed lower value than Sothuparai. Moreover, Periyakulam, Bodi, Aundipatty, Periyakoil, Uthamapalayam River, Sothuparai dam and Vaigai

**Table 3.** Water Quality Index showed excellent water in different sources of Theni district during 2006-2013

Place	Water resource	Year	WQI
Periyakulam	River	2006	30.7863
Periyakulam	River	2008	26.7962
Aadupaalam (Periyakulam)	River	2013	29.2784
Periyakoil (Periyakulam)	River	2013	29.4857
Sothuparai away from dam	River	2013	23.4199
Theerthathotti (Periyakulam)	River	2013	23.2127
Uthamapalayam	River	2007	46.1555
Sothuparai	Dam	2006	36.064
Sothuparai	Dam	2007	45.6619
Vaigai	Dam	2007	43.6419
Sothuparai	Dam	2012	24.0479
Vaigai Dam Near Powerhouse	Dam	2013	48.0966
Muthulapuram	Pond	2007	43.4391
Ramasamaynayakkanpatty	Pond	2007	49.4488
Thirumalapuram	Bore well	2007	38.8064

**Table 4.** Water Quality Index showed good water in different sources of Theni district during 2006-2014

Place	Water resource	Year	WQI
Periyakulam Surface water	River	2007	52.1256
Bodi	River	2007	60.6914
Surulipatty	River	2007	61.3159
Aundipatty	River	2008	77.41479
Periyakoil	River	2013	99.5014
Uthamapalayam	River	2014	99.8265
Sothuparai	Dam	2007	68.01055
Vaigai Dam	Dam	2007	58.6532
Vaigai Dam Near the bridge	Dam	2013	78.678
Vaigai Dam North	Dam	2013	64.9323
Ambasamuthram	Pond	2007	73.53855
Muthulapuram	Pond	2007	73.9196

dam, Ambasamuthram and Muthulapuram pond water was good. Poor water was recorded (as given in table 5) in the places such as rivers of Periyakulam, Bodi, Anamalayanpatti, Hanumanthanpatti, Veerapandi, Bodi Pudur, Dharmathupatti, Renganathapuram, Uppukottai and Melmangalam may be due hardness and high alkalinity of water as in the study of MohammedAli *et al.* (2016) and Chimankpam *et al.* (2019).

Very poor quality of water was observed in

Surulipatty and Vadugapatti during 2007 and Sothuparai dam & Chinnamanur in 2013 and 2014 respectively. Also, bore well water became very poor quality in different places of Theni district as reported by Goher *et al.* (2014). Water unsuitable for drinking in Theni district was from the bore well of Periyakulam, Thamaraiikulam and Vadugapatti unlike the study of Balan *et al.* (2012). The same result was recorded in the report of Ghosh *et al.* (2013) where the water has to be treated before

**Table 5.** Water Quality Index showed poor water in different sources of Theni district during 2006-2014

Place	Water resource	Year	WQI
Bodi	River	2007	120.262
Aadupaalam	River	2013	105.812
Theerthahotti	River	2013	161.45
Anamalayanpatti - Mullayar river	River	2014	113.448
Cumbam - Mullayar river	River	2014	112.956
Hanumanthanpatti-Mullayar river	River	2014	168.323
Veerapandi - Mullayar river	River	2014	133.288
Vaigai Dam Center	Dam	2013	119.928
Vaigai Dam South	Dam	2013	120.695
Vaigai	Dam	2008	121.681
Vadugapatti	Pond	2007	129.1162
Bodi Pudur	Bore well	2007	141.551
Dharmathupatti	Bore well	2007	128.06
Renganathapuram	Bore well	2007	163.799
Uppukottai	Bore well	2007	191.999
Chinnakadai st.	Bore well	2007	198.885
Melmangalam east st.	Bore well	2007	144.2

River water from Surulipatty, Vadugapatti, Sothuparai away from dam, Chinnamanur Mullayar river, water from Sothuparai dam, and bore well water of Anaikaraipatti, Bodi Borewell, Dombuchery, Durairajpuram, Melachokanathapuram, Melmangalam Ammapatti st., Melmangalam West st., Periyakulam, Vadugapatti Thalaivasal and Thamaraiikulam VOC st. showed very poor water in Theni district (Table 6).

**Table 6.** Water Quality Index showed very poor water in different sources of Theni district during 2007-2014

Place	Water resource	Year	WQI
Surulipatty	River	2007	264.905
Vadugapatti	River	2007	249.3135
Sothuparai away from dam	River	2013	295.18
Chinnamanur Mullayar river	River	2014	212.863
Sothuparai dam	Dam	2013	297.129
Anaikaraipatti	Bore well	2007	242.078
Bodi Borewell	Bore well	2007	240.289
Dombuchery	Bore well	2007	216.335
Durairajpuram	Bore well	2007	280.77
Melachokanathapuram	Bore well	2007	294.227
Melmangalam Ammapatti st.	Bore well	2007	293.465
Melmangalam West st.	Bore well	2007	243.031
Periyakulam borewell water	Bore well	2007	276.64
Vadugapatti Thalaivasal	Bore well	2007	237.46
Thamaraiikulam VOC st.	Bore well	2007	262.786
Thamaraiikulam (Union Middle School)	Bore well	2007	284.846

drinking.

In Dindigul district, water from river, dam, bore well, open bore well and pond has quality rating between excellent to unsuitable for drinking. Maruthanathi River was excellent for drinking purpose during 2014, while in 2015 it became poor that needs attention of care to take avoid contamination or treatment before consumption as in the study of MohammedAli *et al.* (2016). Dam water from Manjalar was good in 2007 but became very poor in 2014 need the attention of government to treat this water to be good as Devadhanpatty people are consuming it for as such for daily life. Bore well water of Bharathipuram, Arockiamatha Street, Xavier Street, Devasegamanipuram, Ponthamarai were very poor in condition. Open bore well water of Pannaipatti and Vinayagar colony showed unsuitable for drinking including pond water of Tannery Effluent in Dindigul district which is highly polluted due to domestic sewage. WQI alone is not enough to evaluate the quality of any water but fecal coliform count also should be included for confirming the quality of water as studied by Sim and Tai (2018). Due to seepage of this water, ground water (including Open bore well) gets

highly unsuitable. Hence, measures should be taken to improve the quality of water and manage water to safeguard human health and environment.

## CONCLUSION

WQI is one of the most powerful and effective tool for analyzing water quality and monitor water pollution in any areas and transfers information to policy makers and to the general public. River water of Sothuparai, Periyakulam, Uthamapalayam, Muthulapuram, Vaigai and Thirumalapuram bore well are excellent for drinking purpose. Hierarchy of excellent water source among the Dams based on WQI are Sothuparai > Vaigai > Manjalar. Among the rivers, water of Periyakulam, Uthamapalayam, Muthulapuram and Ramasamynayakanpatti are excellent in quality. This water of excellent quality is the gift of God and humans' capacity is to maintain the same for their progeny. The water holding poor to unsuitable quality need attention of people and authorities to avoid polluting such resources by adding synthetic fertilizers and dumping of waste into water bodies. Dindigul bore well water should be treated before consumption. Due to seepage of

**Table 7.** Water Quality Index showed unsuitable bore well water in Theni district during 2007.

Place	Water resource	Year	WQI
Periyakulam	Bore well	2007	944.085
Thamaraikulam	Bore well	2007	1142.93
Union office st., Vadugapatti	Bore well	2007	356.778
VOC street	Bore well	2007	389.917

**Table 8.** Water Quality Index showed various quality of water in different sources and places of Dindigul during 2007-2015

S. No.	Name of the Place	Class	Year	WQI	Quality rating
1	Bharathipuram	Borewell	2007	186.8309	Poor
2	Devasegamanipuram	Borewell	2007	237.9284	Very Poor
3	East Arockiamatha Street	Borewell	2007	316.1955	Unsuitable for drinking
4	West Arockiamatha Street	Borewell	2007	213.5171	Very Poor
5	Xavier Street	Borewell	2007	222.2919	Very Poor
6	NSNagar	Borewell	2012	389.1686	Unsuitable for drinking
7	Ponthamarai	Borewell	2012	278.0456	Very Poor
8	Pulianatham	Borewell	2012	321.5492	Unsuitable for drinking
9	Manjalar	Dam	2007	55.92708	Good
10	Pannaipatti	Openwell	2012	3808.235	Unsuitable for drinking
11	Vinayagar colony	Openwell	2012	3826.744	Unsuitable for drinking
12	Tannery Effluent Pond	Pond	2012	4625.178	Unsuitable for drinking
13	Maruthanathi	River	2014	49.65082	Excellent
14	Manjalar	Dam	2014	212.9513	Very Poor
15	Maruthanathi	River	2015	160.1243	Poor

this water, ground water gets highly unsuitable and it is high time for the policy makers to be attracted to stop such worsening condition of our environment. For determination of quality of any water faecal coli form count also should be included.

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