IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 6, Issue 4, May 2026

Impact Factor: 8.2

Evaluation of Groundwater Quality for Suitability of Irrigation & Industrial Purposes: A Case Study in Bhusawal Taluka of Jalgaon District Maharashtra, India

S. S. Koranne and Darshana D. Patil*

Department of Civil Engineering

Government College of Engineering Aurangabad, Chatrapati Sambhaji Nagar, Maharashtra, India

*Corresponding author email ID: darshanastar2001@gmail.com

Abstract: *The study of subsurface water quality to evaluate its aptness for agricultural, industrial practice has become essential due to the variability in rainfall intensity and uncertainty in its distribution. In view of this, the geochemical properties of 20 groundwater samples, including electrical conductivity (EC), pH, total dissolved solids, major cations, and anions, are measured and evaluated suitability. The suitability for irrigation purpose advised by appraisal of various cultivation water quality parameters such as sodium percentage (Na%), sodium adsorption ratio (SAR), Kelly's ratio (KR), residual sodium carbonate (RSC), magnesium adsorption ratio (MAR), and permeability index (PI). The industrial applicability was analysed using the Langelier saturation index (LSI), Ryznar stability index (RSI) and Larson–Skold index (LSkI). Geographic information systems (GIS) used the analytical results to produce the numerical spatial dispersion of the indexes. The comprehensive technique of suitability evaluation indicates that subsurface water in the research region is ideal for cultivation. Hence study indicates that, continuous monitoring of quality groundwater resources can play major role for achieving the goal of sustainable development of the Bhusawal Taluka of Maharashtra.*

Keywords: Water quality, Agriculture, Industry, Bhusawal Taluka.

I. INTRODUCTION

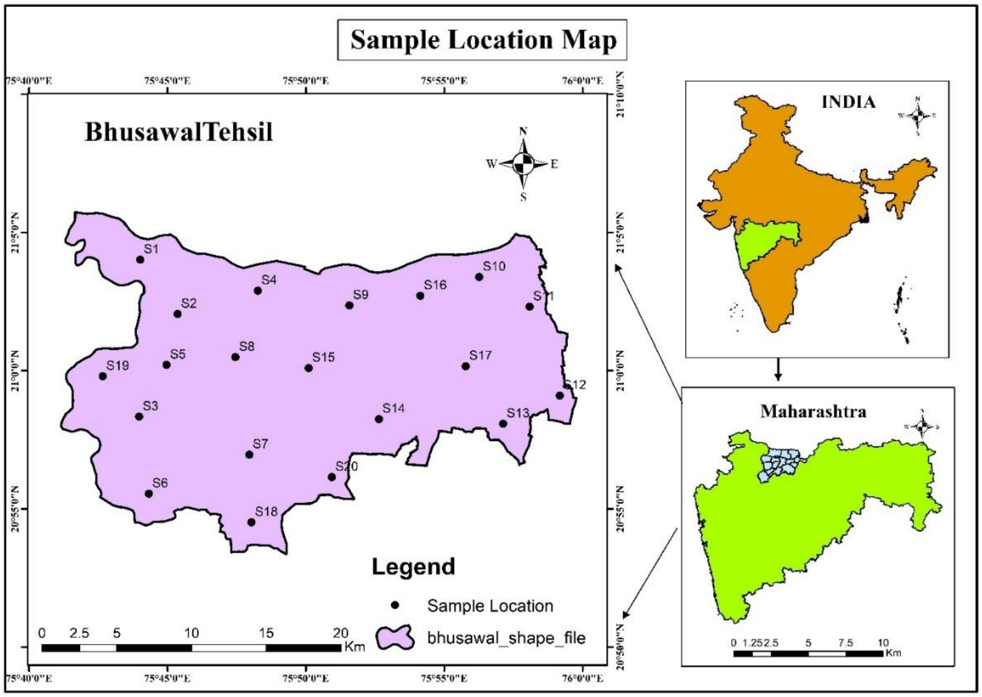
The chemical composition of irrigation water significantly affects soil structure and permeability. Excess concentrations of sodium, carbonate, and bicarbonate ions may lead to soil alkalinity and dispersion of soil particles, resulting in reduced infiltration capacity and poor aeration (Varade et., al., 2018; Singh et., al., 2018; Panaskar et., al., 2016). Parameters such as Sodium Adsorption Ratio (SAR), Sodium Percentage (Na%), Kelly's Ratio (KR), and Residual Sodium Carbonate (RSC) are widely used to evaluate sodium and alkalinity hazards in irrigation water. Continuous use of poor-quality water with high sodium content can deteriorate soil texture, reduce permeability, and adversely affect root development and nutrient uptake by crops (Patil et., al., 2024; Pimparkar et., al., 2023; Markad et., al., 2023; Gandla et., al., 2022). Hence, water quality analysis helps identify potential solidity and alkalinity problems before they become severe (Mahajan et., al., 2016; Narkhede et., al., 2011). Sever researcher has tried to study the related between water quality and irrigation aspects for betterment of society.

Study area:

Bhusawal is an important taluka in northern Maharashtra, known for its agricultural economy and railway connectivity. The population of Bhusawal Taluka has grown steadily due to urbanization, trade, and employment opportunities linked to farming and transport activities. Most people live in rural villages, while Bhusawal city serves as the main commercial and administrative center. Agriculture is the major occupation in the taluka. The irrigation pattern is mainly

DOI: 10.48175/IJARSCT-35166

supported by canals, wells, tube wells, and lift irrigation systems connected to nearby rivers and reservoirs in the Tapi River basin region (Kadam et., al., 2025; Jadhao et., al., 2023). Farmers cultivate crops such as banana, cotton, sugarcane, wheat, and vegetables. Bhusawal is especially famous for banana production because of fertile black soil and availability of irrigation water. Drip irrigation is also increasingly used to conserve water and improve crop productivity.



II. METHODOLOGY

The field data assemblage was carried out in Bhusawal Taluka of Jalgaon District, Maharashtra State, using a toposheets published by Survey of India. Bhusawal Taluka is mainly covered under the Survey of India (SOI) toposheet number 46 P/13. Some adjoining parts of the taluka may also extend into nearby sheets such as 46 P/9 and 46 O/16, depending on the exact village or location. During the pre-monsoon season in 2025, Total 20 subsurface water samples were collected from multiple sites within the research region. After repeatedly pumping out for 30 minutes, water samples were taken from the dug/tube wells. (Abadi et., al., 2025; Alitane et., al., 2025; Boukich et., al., 2025) The samples were collected in 1 litre clean polythene bottles, and they were fully sealed after collection. Till the evaluation was finished, the samples were stored in a refrigerator at 4°C. The study region was determined using the Geographical Information System software (Arc GIS version: 10.8 software). Using Arc GIS software, the sites are then marked on the geo-referenced map. The Global Positioning System (GPS) was utilized to pinpoint groundwater sample locations in the field (Fig.1). The following formulas have been applied for SAR, Na %, RSC, MAR, KR and PI indices along with Langelier saturation index (LSI), Ryznar saturation index (RSI) and Larson-Skold index (LSkI) valuation (Mallick et., al., 2021; Taghavi et., al., 2019). Table no.3 illustrates the highest and lowest values of cultivation and industrial water quality indices.

$$SAR = \frac{Na^{+}}{\sqrt{(Ca^{2+} + Mg^{2+})/2}} \qquad (1)$$

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 4, May 2026
Impact Factor: 8.2

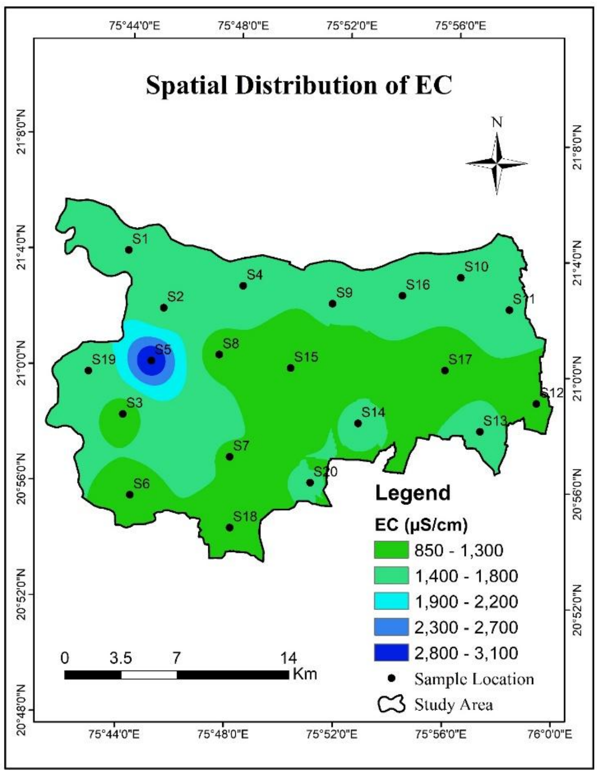
$Na\% = \frac{Na^{+} + K^{+}}{Ca^{2+} + Mg^{2+} + Na^{+} + K^{+}} \times 100$	(2)
$RSC = (CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$	(3)
$MAR = \frac{Mg^{2+}}{(Ca^{2+} + Mg^{2+})} \times 100$	(4)
$KR = \frac{Na^{+}}{(Ca^{2+} + Mg^{2+})}$	(5)
$PI = \frac{Na^{+} + \sqrt{HCO_3^{-}}}{Ca^{2+} + Mg^{2+} + Na^{+}} \times 100$	(6)
$LSI = pHa - pHs$	(7)
$RSI = 2(pH_S) - pH$	(8)
$LSkI = \frac{Cl^{-} + SO_4^{2-}}{HCO_3^{-} + CO_3^{2-}}$	(9)

III. RESULTS AND DISCUSSIONS

The hydrogeochemical evaluation of groundwater samples collected from Bhusawal Taluka reveals that the overall groundwater quality is predominantly suitable for irrigation purposes with minor localized constraints. The sodium percentage (Na%) values ranging from 17.99% to 30.85% indicate excellent to good quality irrigation water, suggesting low sodium hazard and minimal risk of soil dispersion or permeability reduction. Similarly, the soluble sodium percentage (SSP) values remain well below the critical limit of 50%, further confirming that the groundwater is safe for agricultural applications and unlikely to adversely affect soil texture or crop productivity. The low sodium adsorption ratio (SAR) values, varying between 0.85 and 2.58, classify all groundwater samples within the excellent category for irrigation, indicating that sodium-induced alkalinity hazards are insignificant across the study area. The permeability index (PI) values, ranging from 30.43 to 46.49, place all samples within Doneen's Class II category, demonstrating that the groundwater possesses good permeability characteristics suitable for sustained irrigation practices. This suggests that long-term application of groundwater is unlikely to create serious infiltration or permeability problems in agricultural soils. In addition, Kelly's Ratio (KR) values between 0.21 and 0.44 remain below the permissible threshold of unity, signifying the dominance of calcium and magnesium ions over sodium ions and confirming the suitability of groundwater for irrigation purposes. These indices collectively indicate that groundwater within the study area is chemically favorable for agricultural use and capable of supporting the cultivation of major regional crops such as banana, cotton, wheat, sorghum, and sugarcane. Despite the generally favorable irrigation characteristics, the residual sodium carbonate (RSC) values demonstrate considerable spatial variation and indicate potential alkalinity hazards in several locations. The observed RSC values range from −7.20 to 13.64 meq/L. Negative RSC values recorded in some samples indicate the dominance of calcium and magnesium ions, which contribute positively to soil structure stability and improve irrigation suitability. However, several samples exhibit RSC values significantly exceeding the permissible limit of 2.5 meq/L, indicating excess carbonate and bicarbonate concentrations capable of precipitating calcium and magnesium from soil solution. Such conditions may gradually increase sodium accumulation in soils, reduce infiltration capacity, and promote the development of alkaline soil conditions if groundwater is continuously used for irrigation without appropriate management measures. Therefore, groundwater

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 4, May 2026
Impact Factor: 8.2

from high-RSC zones requires careful agricultural management, including gypsum application, adequate drainage, periodic soil monitoring, and blending with low-alkalinity water to minimize long-term soil degradation. The magnesium adsorption ratio (MAR) values vary from 34.37% to 51.79%, indicating that most groundwater samples are within the acceptable range for irrigation use. However, isolated samples exceeding the critical threshold of 50% suggest localized magnesium hazards that may adversely affect soil quality and crop productivity over prolonged irrigation periods. Elevated magnesium concentrations can increase soil alkalinity and negatively influence soil aggregation and permeability. Nevertheless, the predominance of acceptable MAR values across the majority of samples indicates that magnesium-related hazards are not widespread within the study area. The chloro-alkaline indices (CAI-1 and CAI-2) exhibit both positive and negative values, indicating the occurrence of active ion exchange processes between groundwater and aquifer materials. Positive CAI values suggest direct ion exchange reactions in which sodium and potassium ions from groundwater are exchanged with calcium and magnesium ions present in host rocks, whereas negative values indicate reverse ion exchange processes. These hydrogeochemical interactions reflect the influence of basaltic lithology associated with the Deccan Trap formations that dominate the regional geology of Bhusawal Taluka. The observed ion exchange mechanisms confirm that groundwater chemistry is significantly controlled by water-rock interaction processes, mineral dissolution, and geochemical evolution during subsurface circulation.



IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 4, May 2026 Impact Factor: 8.2

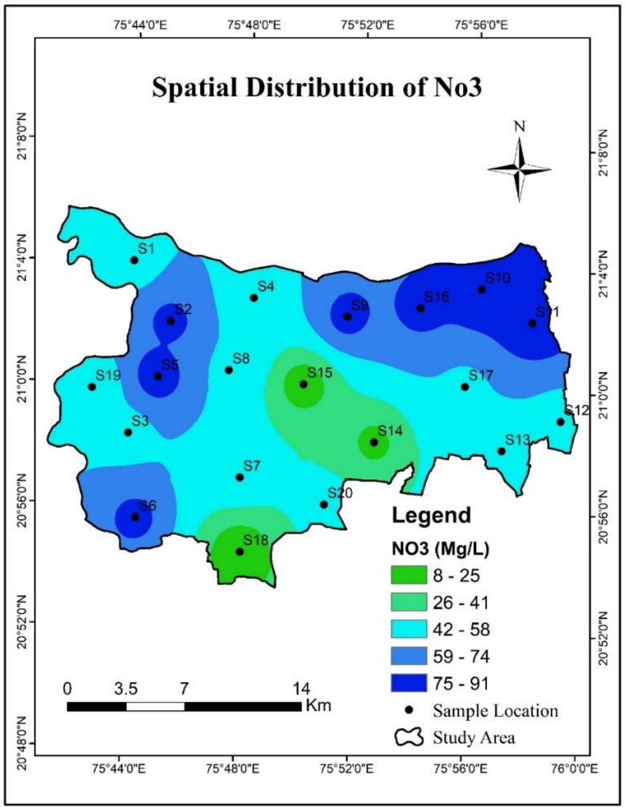


Table no. 1: Major physicochemical parameters of groundwater samples w.r.t. WHO 2011

Parameters	Unit	Mini	Max	% of Water samples beyond permissible limit	WHO 2011
EC	µs/cm	850	3110	10	1500
TDS	mg/l	520	1950	90	500
pH	-	6.9	7.9	05	6.5-8.5
Ca	mg/l	83	276	05	200
Mg	mg/l	35	98	00	150
Na	mg/l	40	196	00	200
K	mg/l	2.3	9	00	12
Cl	mg/l	56	600	25	200
NO3	mg/l	8.36	91	80	45
SO4	mg/l	9.02	83	00	200
F	mg/l	0.1	0.9	00	1.5

Table no. 2: Details of physicochemical parameters of subsurface water samples

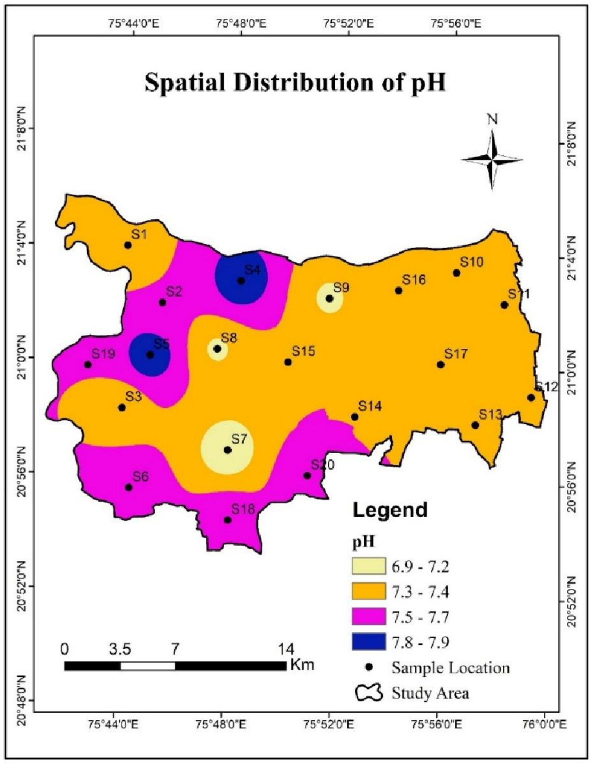
ID	pH	Ca	Mg	Na	K	HCO3	SO4	Cl	NO3	F	TDS	EC
Unit	-	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	µs/cm
1	7.2	112	60	54	6	225	21	280	49	0.6	815	1310

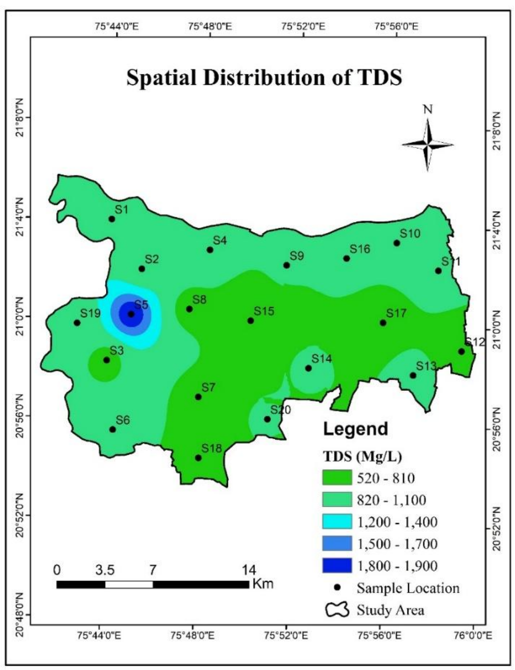
2	7.4	105	45	52	9	460	24	89	80	0.7	875	1450
3	7.2	92	45	40	3.2	280	60	108	52	0.9	695	1120
4	7.9	98	46	63	4	510	62	56	46	0.9	905	1460
5	7.9	276	98	196	6.7	612	83	600	87	0.4	1950	3110
6	7.6	105	45	52	9	460	24	89	80	0.7	875	1200
7	6.9	110	43	65	2.3	220	30	200	51	0.1	720	1290
8	7.1	90	43	67	2.3	220	30	180	54	0.3	690	1100
9	7.1	109	41	59	3.8	294	60	180	81	0.1	835	1340
10	7.2	110	35	84	3.4	300	14.96	230	89	0.4	865	1360
11	7.4	143	49	65	3.1	380	77	126	91	0.1	950	1510
12	7.4	83	36	61	2.5	198	49.6	160	51	0.1	650	1050
13	7.4	108	47	76	3.8	310	66	220	48.3	0.1	880	1410
14	7.4	95	62	66	3.6	370	16.89	190	20	0.1	835	1340
15	7.4	88	42	50	5	210	42	70	11.95	0.1	520	850
16	7.4	105	45	52	9	460	24	89	80	0.7	870	1400
17	7.4	90	43	67	2.3	220	30	180	54	0.3	685	1150
18	7.6	110	38	68	3.4	364	9.02	110	8.36	0.8	720	1215
19	7.4	103	47	71	3.8	370	12	198	41	0.12	855	1360
20	7.6	117	60	54	6	225	21	280	49	0.6	820	1310
Max		276	98	196	9	612	83	600	91	0.9	1950	3110
Min		83	35	40	2.3	198	9.02	56	8.36	0.1	520	850

The physicochemical analysis of groundwater samples indicates considerable variation in water quality parameters across the study area. Electrical Conductivity (EC) values range from 850 to 3110 µs/cm, with 10% of samples exceeding the WHO (2011) permissible limit of 1500 µs/cm. Elevated EC reflects higher ionic concentration and suggests mineral dissolution and possible anthropogenic contamination. Total Dissolved Solids (TDS) vary between 520 and 1950 mg/l, and a significant 90% of water samples exceed the WHO guideline value of 500 mg/l. This indicates that most groundwater samples are highly mineralized and may affect palatability and suitability for drinking purposes. The pH values range from 6.9 to 7.9, indicating that groundwater is generally neutral to slightly alkaline in nature. Only 5% of samples fall outside the acceptable range of 6.5–8.5, showing that pH is not a major concern in the area. Calcium (Ca) concentrations range from 83 to 276 mg/l, with 5% of samples exceeding the permissible limit of 200 mg/l, suggesting localized hardness issues. Magnesium (Mg) concentrations vary between 35 and 98 mg/l, remaining well within the WHO permissible limit of 150 mg/l in all samples. Similarly, Sodium (Na) values range from 40 to 196 mg/l and Potassium (K) from 2.3 to 9 mg/l, both remaining within permissible limits, indicating limited sodium and potassium hazards in groundwater. Chloride (Cl) concentrations range from 56 to 600 mg/l, with 25% of samples exceeding the WHO permissible limit of 200 mg/l. High chloride levels may result from agricultural runoff, sewage infiltration, or evaporation processes, and can impart a salty taste to water. Nitrate (NO_3) concentrations show substantial variation from 8.36 to 91 mg/l, with 80% of samples exceeding the permissible limit of 45 mg/l. This is a serious concern because elevated nitrate levels are commonly associated with excessive fertilizer application, septic tank leakage, and organic waste contamination. High nitrate concentrations pose health risks such as methemoglobinemia or "blue baby syndrome" in infants. Sulphate (SO_4) concentrations range from 9.02 to 83 mg/l, remaining below the WHO permissible limit of 200 mg/l in all samples, indicating no sulphate-related contamination.

ISSN: 2581-9429
Volume 6, Issue 4, May 2026
Impact Factor: 8.2

Fluoride (F) values vary from 0.1 to 0.9 mg/l, which are well within the permissible limit of 1.5 mg/l, suggesting that fluoride-related health issues such as fluorosis are unlikely in the study area.





DOI: 10.48175/IJARSCT-35166

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429 Volume 6, Issue 4, May 2026 Impact Factor: 8.2

The industrial suitability assessment based on saturation and stability indices indicates that groundwater in the study area exhibits moderate scaling and mild corrosive tendencies. The Langelier Saturation Index (LSI) values ranging from −0.41 to 1.30 suggest that most groundwater samples possess scale-forming characteristics due to supersaturation with respect to calcium carbonate. Positive LSI values indicate the likelihood of scale deposition within industrial pipelines, boilers, and cooling systems, while a few negative values indicate localized corrosive tendencies.

Table no. 3: Concentration of subsurface water quality indicators for irrigation and industry

ID	**Na%**	**PI**	**RSC**	**KR**	**MAR**	**SSP**	**CAI 1**	**CAI 2**	**SAR**	**LSI**	**RSI**	**LSkI**
Unit	%	-	meq/l	-	%	-	-	-	-	-	-	-
1	19.18	34.85	-5.12	0.22	46.86	18.22	0.68	0.75	1.02	-0.093	7.4	1.094545
2	21.77	30.93	-5.66	0.25	41.37	20.16	0.01	0	1.07	0.37	6.7	0.235417
3	17.99	30.57	-3.7	0.21	44.6	17.32	0.4	0.19	0.85	-0.059	7.4	0.509091
4	24.65	32.36	-3.94	0.32	43.59	23.98	-0.8	-0.2	1.31	0.89	6.2	0.203448
5	28.45	38.36	-7.2	0.39	36.89	28.04	0.49	0.46	2.58	1.3	5.4	1.116013
6	21.77	30.93	-1.66	0.25	41.37	20.16	0.01	0	1.07	0.64	6.4	0.217308
7	24.19	39.08	1.07	0.31	39.15	23.82	0.49	0.23	1.33	-0.41	7.6	0.851852
8	26.99	42.28	2.75	0.36	44.02	26.6	0.41	0.16	1.45	-0.27	7.6	0.807692
9	23.18	37.6	2.96	0.29	38.24	22.52	0.48	0.16	1.22	-0.053	7.3	0.677966
10	30.85	46.49	5.22	0.44	34.37	30.35	0.42	0.16	1.78	0.018	7.2	0.720471
11	20.62	30.43	1.72	0.25	36.06	20.17	0.18	0.04	1.2	0.42	6.6	0.5075
12	27.63	43.75	7.34	0.37	41.66	27.16	0.4	0.11	1.41	-0.025	7.6	0.845161
13	26.85	41.39	7.17	0.36	41.74	26.28	0.45	0.15	1.54	0.2	7	0.817143
14	23.11	36.43	7.1	0.29	51.79	22.56	0.45	0.14	1.29	0.25	6.9	0.440191
15	22.66	32.35	8.12	0.28	44	21.67	-0.17	-0.02	1.1	0.057	7.4	0.430769
16	21.77	30.93	8.34	0.25	41.37	20.16	0.01	0	1.07	0.38	6.6	0.226
17	26.99	42.28	11.75	0.36	44.02	26.6	0.41	0.1	1.45	0.023	7.4	0.777778
18	26.08	37.12	11.01	0.34	36.25	25.52	0.02	0	1.42	0.52	6.5	0.245909
19	26.09	40.38	13.06	0.34	42.89	25.5	0.43	0.1	1.45	0.28	6.9	0.446809
20	18.82	34.18	13.64	0.22	45.77	17.87	0.68	0.21	1.01	0.31	6.9	1.094545
Max	30.85	46.49	13.64	0.44	51.79	30.35	0.68	0.75	2.58	1.3	7.6	1.116013
Mini	17.99	30.43	-7.2	0.21	34.37	17.32	-0.8	-0.2	0.85	-0.41	5.4	0.203448

Similarly, the Ryznar Stability Index (RSI) values between 5.4 and 7.6 indicate that most samples fall within the slightly scale-forming to nearly stable category, although a few samples display corrosive behavior. The lower RSI values observed in certain samples indicate stronger scaling potential, whereas higher values reflect greater corrosion susceptibility. The Larson–Skold Index (LSkI) values ranging from 0.20 to 1.12 indicate low to moderate corrosion potential in groundwater across the study area. Most samples fall within the low corrosion category, suggesting that groundwater can generally be utilized for industrial purposes without severe deterioration of metallic infrastructure. However, moderate corrosion tendencies observed in some samples imply that prolonged use without treatment may contribute to gradual corrosion of pipes, pumps, and industrial equipment. Consequently, industrial utilization of groundwater in the study area may require pretreatment measures such as softening, pH adjustment, anti-scalant dosing, and corrosion control to ensure operational efficiency and minimize maintenance costs.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 4, May 2026
Impact Factor: 8.2

Table no. 4: Subsurface water classification according to Handa

EC µs/cm	Classification	No. of respective samples	% of samples
Less than 250	Brilliant	00	00
250-750	Good	00	00
750-2250	Permissible	19	95
2250-5000	Doubtful	01	05

Table no. 5: RSC sorting of groundwater

RSC	Class	No. of respective samples	% Samples
<1.5 meq/l	Safe	07	35
1.5 - 2.5 meq/l	Permissible	01	05
> 2.5 meq/l	Not safe	12	60

Table no. 6: Langelier saturation index (LSI) as per Tchobanoglous, et al, 2003

LSI value	Classification	No. of respective samples	% of samples
LSI < 0	Undersaturated	06	30
LSI = 0	Neutral	03	15
LSI > 0	Supersaturated	11	55

Table no. 7: Ryznar stability index (RSI) as per Tchobanoglous, et al, 2003

RSI value	Classification	No. of respective samples	% of samples
RSI < 5.5	Heavy scaling tendency	01	05
5.5 <RI < 6.2	Moderate scaling tendency	01	05
6.2 <RI < 6.8	Neutral	5	25
6.8 <RI < 8.5	Aggressive tendency	13	65
RI > 8.5	Very Aggressive tendency	00	00

Table no. 8: Larson-Skold index (LSkI) as per Tchobanoglous, et al, 2003

LSkI value	Classification	No. of respective samples	% of samples
< 0.8	Low corrosion tendency	14	70
0.8 < LSkI < 1.2	Moderated corrosion tendency	6	30
> 1.2	High corrosion tendency	00	00

IV. CONCLUSION

Water quality analysis plays a crucial role in determining the suitability of groundwater and surface water for irrigation purposes, particularly in agriculturally dominant regions such as Bhusawal Taluka. Irrigation water directly influences soil properties, crop growth, agricultural productivity, and long-term sustainability of farming systems. Therefore, the evaluation of irrigation water quality is essential to prevent soil degradation, maintain crop yield, and ensure efficient utilization of water resources under increasing agricultural and climatic stress conditions. The hydrochemical characteristics of groundwater in Bhusawal Taluka indicate that the water is generally suitable for irrigation and moderately suitable for industrial applications. The groundwater exhibits low sodium hazard, good permeability characteristics, and favorable sodium-related indices, making it appropriate for agricultural use in most parts of the study area. However, elevated residual sodium carbonate values in several locations highlight the potential risk of soil alkalinity under prolonged irrigation conditions. Industrial assessment indicates moderate scale-forming tendencies with localized corrosion risks, suggesting that minor treatment and routine maintenance are necessary before industrial utilization. The hydrogeochemical behaviour of groundwater is primarily controlled by basaltic geology, water-rock interaction, ion exchange processes, and possible anthropogenic influences such as agricultural return flow and evaporation effects.

Conflict of interest:

The authors confirm that there are no known conflicts of interest associated with this publication.

Acknowledgement:

The authors are grateful to the Principal, Government College of Engineering Aurangabad, Chatrapati Sambhaji nagar, Maharashtra, India for necessary research facilities.

REFERENCES

[1]. Abadi, H. T., Alemayehu, T., & Berhe, B. A. (2025). Assessing the suitability of water for irrigation purposes using irrigation water quality indices in the Irob catchment, Tigray, Northern Ethiopia. *Water Quality Research Journal*, *60*(1), 177-195.

[2]. Alitane, A., Essahlaoui, A., Yimer, E. A., Essahlaoui, N., Chawanda, C. J., El Yousfi, Y., & Van Griensven, A. (2025). The combined use of GIS and water quality indices for environmental assessment of Ouislane River watershed, Morocco. *Euro-Mediterranean Journal for Environmental Integration*, *10*(2), 669-687.

[3]. Boukich, O., Ben-tahar, R., Brahmi, M., Alzain, M. N., Noman, O., Shahat, A. A., & Smiri, Y. (2025). Assessment of groundwater quality for irrigation using a new customized irrigation water quality index. *Journal of Hydrology: Regional Studies*, *59*, 102346.

[4]. Gandla, S., Umrikar, B., George, N. J., & Gupta, G. (2024). Geochemical assessment of groundwater quality for domestic, irrigation and industrial purposes: a tool for environmental monitoring and assessment in a semiarid region of eastern Maharashtra, India. *Discover Water*, *4*(1), 98.

[5]. J. Mallick, A. Kumar, M.K. Almesfer, M. Alsubih, C.K. Singh, M. Ahmed and R.A. Khan, (2021) An index-based approach to assess groundwater quality for drinking and irrigation in Asir region of Saudi Arabia. Arabian Journal of Geosciences; 14, 1-17. doi:10.1007/s12517-021-06506-8.

[6]. J. Mallick, C.K. Singh, M.K. AlMesfer, A. Kumar, R.A. Khan, S. Islam and A. Rahman (2018) Hydro-Geochemical Assessment of Groundwater Quality in Aseer Region, Saudi Arabia. Water; 10 (12), pp. 1847-1861, doi: https://doi.org/10.3390/w10121847

[7]. Jadhao, A. V. P., Ahire, P. N., Bankar, S. B., Chavhan, T. M., Nagargoje, A. S., & Birhade, P. M. (2023). The comparative study of waste water and purified water present in sewage treatment plant in Bhusawal City. *International Research Journal of Engineering and Technology (IRJET)*, *10*(4), 65-69.

[8]. Kadam, A., Umrikar, B. N., & Sarkar, S. (2025). Hydrogeospatial and GRACE-Satellite Data Based Investigation of Groundwater Recharge Dynamics in Jalgaon, Maharashtra. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *10*, 279-286.

[9]. Mahajan, S. R., & Chaudhari, V. (2016). EVALUATION OF PHYSICO-CHEMICAL PARAMETERS OF RIVER TAPTI, NEAR ZUGADEVI TEMPLE, BHUSAWAL (MS) INDIA. *International Journal of Pharmacology and Biological Sciences*, *10*(3), 39.

[10]. Markad, A. T., Landge, A. T., Kulkarni, A. S., Sutar, V. B., & Meshre, S. D. (2023). Correlation analysis of various water quality parameters of the tiru reservoir, Maharashtra, India. *International Journal of Bio-Resource and Stress Management*, *14*(Oct, 10), 1411-1429.

[11]. Narkhede, S. R., Patil, N. S., & Chaudahri, R. R. (2011). CORRELATION AND REGRESSION STUDY ON PHYSICO-CHEMICAL PARAMETERS OF UNDERGROUND WATER IN DIFFERENT WARDS

OF SOUTH ZONE OF BHUSAWAL. DIST- JALGAON,(M. S.). *International Journal of Chemical Sciences*, *9*(3), 1435-1440.

[12]. Panaskar, D. B., Wagh, V. M., Muley, A. A., Mukate, S. V., Pawar, R. S., & Aamalawar, M. L. (2016). Evaluating groundwater suitability for the domestic, irrigation, and industrial purposes in Nanded Tehsil, Maharashtra, India, using GIS and statistics. *Arabian Journal of Geosciences*, *9*(13), 615.

[13]. Patil, B. D., Patil, S. N., Patil, A. S., & Chavan, A. B. (2024). Characterization of Groundwater Suitability for Industrial and Irrigation Potential in Shahada Tehsil, Nandurbar District, Maharashtra, India. *Bulletin of Pure & Applied Sciences-Mathematics*, *43*(2).

[14]. Pimparkar, A. M., Patil, S. N., Patil, B. D., & Kadam, A. K. (2023). Comparative assessment of wetland water quality from rural and urban area of Aurangabad District, Maharashtra, India using water quality index. *HydroResearch*, *6*, 269-278.

[15]. Singh, S., Ghosh, N. C., Gurjar, S., Krishan, G., Kumar, S., & Berwal, P. (2018). Index-based assessment of suitability of water quality for irrigation purpose under Indian conditions. *Environmental monitoring and assessment*, *190*(1), 29.

[16]. Taghavi, M., Mohammadi, M. H., Radfard, M., Fakhri, Y., and Javan, S., (2019) Assessment of scaling and corrosion potential of drinking water resources of Iranshahr. MethodsX; 6, 278-283. doi: https://doi.org/10.1016/j.mex.2019.02.002

[17]. Tchobanoglous, G., F.L. Burton, et al., Wastewater Engineering. New York, McGraw Hill (2003).

[18]. Varade, A. M., Yenkie, R. O., Shende, R. R., Golekar, R. B., Wagh, V. M., Khandare, H. W., & Janardan, M. (2018). Assessment of water quality for the groundwater resources of urbanized part of the Nagpur District, Maharashtra (India). *American Journal of Water Resources*, *6*(3), 89-111.