E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 600-604
Received: 4-09-2025
Accepted: 09-10-2025

Niwas G Budhawat
M.Sc. Scholar, Department of Soil Science, College of Agriculture (MPKV), Dhule, Maharashtra, India

VP Bhalerao
Professor (CAS), Department of Soil Science, College of Agriculture (MPKV), Dhule, Maharashtra, India

AA Patil
Subject Matter Specialist, Department of Soil Science, Krishi Vigyan Kendra (MPKV), Dhule, Maharashtra, India

JV Kathepuri
Subject Matter Specialist, Department of Agronomy, Krishi Vigyan Kendra (MPKV), Dhule, Maharashtra, India

AR Mendhe
Jr. Soil Chemist, Banana Research Station, Jalgaon, Maharashtra, India

PM Jagtap
M.Sc. Scholar, Agronomy Section, College of Agriculture (MPKV), Dhule, Maharashtra, India

Corresponding Author:
Niwas G Budhawat
M.Sc. Scholar, Department of Soil Science, College of Agriculture (MPKV), Dhule, Maharashtra, India

Assessment of ground water quality for irrigation in Tapi command area of Dhule District: II. pH, EC and derived parameters

Niwas G Budhawat, VP Bhalerao, AA Patil, JV Kathepuri, AR Mendhe and PM Jagtap

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12i.4431

Abstract
The investigation was carried out on 'Assessment of ground water quality for irrigation in Tapi command area of Dhule district' during the year 2024-25 with the objectives to assess the pH, electrical conductivity and derived parameters in irrigation water from Tapi command area of Dhule district and to classify water for its suitability for irrigation in Tapi command area. A systemic survey was carried out in Tapi river command area and depending upon the variation in physiographic units in the study area. Total 100 irrigation water samples (open well and tube well) were collected during the month of April and May 2024 at grid of 5 km x 5 km with GPS location. The samples were analyzed in the laboratory for pH and EC, derived parameters i.e. SAR, RSC were computed by using standard procedures. The data thus obtained was interpreted with their relative properties and categorized as per ratings of irrigation water quality. In Tapi command area, 51% samples were neutral and 49% samples were moderately alkaline. Regarding electrical conductivity, 52% samples were good and 48% samples under permissible limit. The Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) were in safe limit.

Keywords: Tapi command, Water quality, pH, EC, SAR, RSC

Introduction
One of the most valuable natural resources in the earth's atmosphere is groundwater. According to Steube *et al.* (2009) [19], it promotes environmental functions, socioeconomic growth, and human health. Because the quality of ground water has a direct impact on soils, crops, and crop management, ground water is an essential part of the agricultural support system. Any society's socioeconomic development depends equally on the amount and quality of its groundwater (Omran *et al.*, 2014) [15]. Concern over the degradation of ground water quality brought on by anthropogenic and geogenic activity is growing. If the water comes from surface water bodies (rivers and ponds) or groundwater aquifers with different geologies, as well as if the water has undergone chemical treatment, can also have a significant impact on the quality of the water that is available locally. According to Ayers and Westcot (1985) [4], the chemical components of ground water can either directly or indirectly impact plant growth by causing toxicity or deficiencies or by changing the availability of vital nutrients.
The third-largest Indian state, Maharashtra, is situated in the west-central region, close to the Arabian Sea, between latitudes 15°45' and 22°00' N and longitudes 73°00' and 80°59' E. Its entire land area is 30.8 million hectares, of which 4.6 million are arable land that is irrigated by lift irrigation, canals, or wells. With only 15.8% of the entire agricultural area under irrigation, the majority of which is located in Western Maharashtra, the state mainly relies on natural rainfall (Anonymous, 2020) [1]. Based on geological age and hydrogeological characteristics, the aquifers are divided into nine distinct hydrogeological sub-groups and three main hydrogeological groups: unconsolidated, semi-consolidated, and consolidated. The best groundwater reservoirs are the unconsolidated formations made up of recent alluvium that encompass an area of 14,526 square kilometres. Their granular structure gives them exceptional porosity and permeability because of their linked pore spaces (Brhane, 2016) [5].

The Satpuda hill's base is where the Dhule district is located. The Dhule district has a total land area of 7,19,500 hectares. There are 5,54,687 hectares of cultivable land in the Dhule district. Dhule tahsil's total irrigated area is 1,19,441 hectares. The district is traversed by the Tapi, Panzara, Kan, Arunavati, Amravati, Aner, Evil, and Sandy rivers. There are four talukas in the Dhule district: Dhule, Sakri, Shindkheda, and Shirpur. There are 683 villages and over 23,695 wells dug in the Dhule district overall. The quality of irrigation water and related risks to crop output and soil properties are complicated phenomena that depend on a number of interrelated factors. It is impossible to overstate how vital water is to human society (Anonymous, 2020) [1].

The suitability of groundwater for irrigation is determined by a number of parameters, such as crop kinds, land use, irrigation technique, soil texture and composition, and water quality (Thilagavathi *et al*., 2015; Jasmin and Mallikarjuna, 2015) [24, 11]. The kind of water and the concentration of salt and dissolved solids determine the quality of irrigation water (Arya *et al*. 2019; Etteieb *et al.* 2017) [3, 9]. For agricultural areas to flourish sustainably, it is essential to routinely check the quality of the irrigation water (Subba Rao, 2018) [21]. In order to evaluate the quality of groundwater for irrigation purposes, several irrigation parameters have been used, including percent sodium (Na), sodium absorption ratio (SAR), residual sodium carbonate (RSC), permeability index (PI), Keller index (KI), and magnesium hazard ratio (MHR) (Chemura, *et al*. 2014; Gautam, *et al*. 2015; Mohammad and Hassan 2016) [6, 10, 14].

Materials and Methods

A systemic survey was carried out in Tapi river command area and depending upon the variation in physiographic units in the study area. The village cadastral maps were used as base maps for delineating boundaries with actual observations throughout the course of traversing. Total 100 irrigation water (open well and tube well) samples were collected during the month of April and May 2024 at grid of 5 km x 5 km with GPS location. Water samples were collected in closed air tight plastic bottles and transported to laboratory for analysis. The sampling was done within 24 hrs of water collection. The samples were analyzed in the laboratory for pH by potentiometry, Electrical conductivity by conductometry. Different water quality indices i.e. Sodium Adsoption Ratio (SAR) was computed as given by Richards (1954) [18] and Residual Sodium Carbonate (RSC) was computed as given by Eaton (1950) [7].

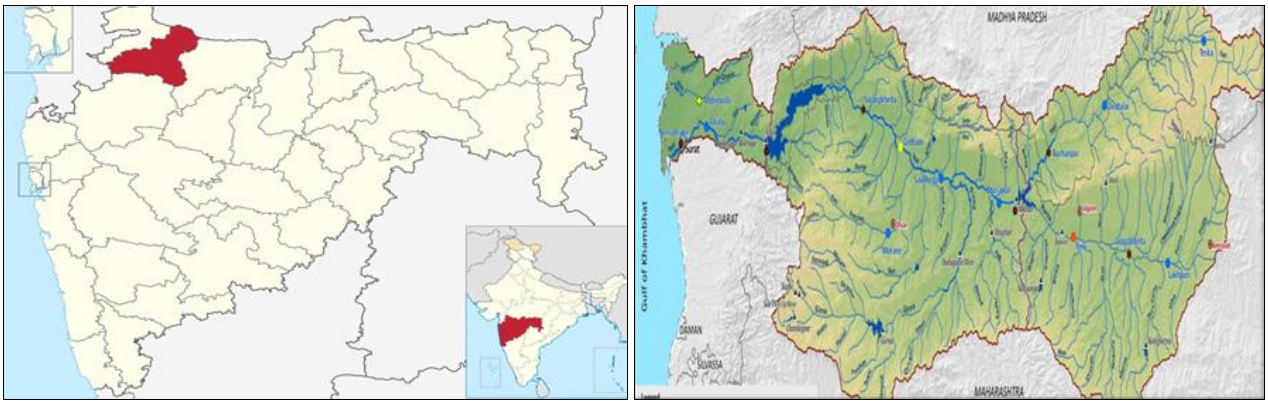

Fig 1: Location Map of Tapi Command Area

Results and Discussion

Irrigation water quality

pH

A total of 51% samples across the region (24 from Shirpur and 27 from Sindkheda) were categorized as neutral (6.5 to 7.5). These irrigation water samples are generally safe and suitable for all types of crops and soils, requiring minimal or no pH correction. The remaining 49% samples (26 from Shirpur and 23 from Sindkheda), were found to be moderately alkaline (7.6 to 8.5). Although irrigation water with this pH is still usable, continuous use over time can lead to alkalinity buildup in the soil, particularly in poorly drained or sodic soils. However, no samples were found in the strongly alkaline category (>8.5), signifying the absence of potentially hazardous alkaline irrigation waters in the study area. The maximum pH observed was 8.19 in Shirpur and 8.20 in Sindkheda, indicating a mild level of alkalinity but still within acceptable irrigation thresholds. The mean pH was recorded as 7.59 for both Shirpur and Sindkheda, and slightly lower at 7.54 for the overall Tapi command area. These values clearly fall within the moderately alkaline range, suggesting that the irrigation water is largely suitable for irrigation, monitoring for potential sodicity hazards may be required if this irrigation water is used continuously over a long period. The standard deviation (SD) values were 0.33 for Shirpur, 0.36 for Sindkheda, and 0.35 for the Tapi command area, indicating low variability among the samples. Comparable results were reported by Elsayed *et al*. (2020) [8] and Patel *et al*. (2021) [16].

Electrical conductivity

The EC values of the irrigation water samples were grouped into five standard categories to assess their suitability for irrigation. Notably, none of the samples from Shirpur, Sindkheda, or the overall Tapi command area was under the “Doubtful” (2.25 to 3.00 dS m^{-1}) and “Unsuitable” (> 3.00 dS m^{-1}) categories. This is a positive indication that no highly saline irrigation water was present in the area. Out of the 100 samples, 52% samples (23 from Shirpur and 29 from Sindkheda) were under the “Good” category (EC 0.25 to 0.75 dS m^{-1}). Irrigation water in this category is generally considered safe for irrigation, particularly in well-drained soils and salt-tolerant crops. The remaining 48% samples (27 from Shirpur and 21 from Sindkheda) were categorized as “Permissible” (0.75 to 2.25 dS m^{-1}). While irrigation water in this range can still be used for irrigation, precautionary measures such as proper drainage and periodic leaching are recommended to prevent salt accumulation in the root zone. The maximum EC values were 1.23 dS m^{-1} in Shirpur and 1.28 dS m^{-1} in Sindkheda, resulting in an overall maximum of 1.28 dS m^{-1} for the command area. These values comes under within the “Permissible” category, reflecting that no serious

salinity hazard exists under current usage conditions. The mean EC values were 0.66 dS m^{-1} for Shirpur and 0.72 dS m^{-1} for Sindkheda, with mean of 0.69 dS m^{-1} for the entire Tapi command area. These mean values lie on the borderline of the good to permissible range, suggesting the irrigation water is generally suitable for irrigation but may require monitoring in long-term applications. Similar findings were reported by Kumawat *et al.* (2024) [12] and Suresh *et al.* (2024) [23].

Sodium Adsorption Ratio (SAR)

The Sodium Adsorption Ratio (SAR) is a critical parameter used to evaluate the suitability of irrigation water based on its sodium content relative to calcium and magnesium. High SAR levels can impair soil permeability, leading to reduced irrigation water infiltration and poor crop productivity. The categorization of SAR values in the irrigation water samples from the Tapi command area is presented in table 4.23. The findings reveal that all 100% irrigation water samples analyzed across the region including 50 samples each from Shirpur and Sindkheda tehsils, each were categorized under the low SAR category (<10). This indicates that the irrigation water is safe and suitable for irrigation from a sodicity perspective, as low SAR values suggest minimal risk of sodium hazard to soil structure. No samples were recorded in the moderately safe (10 to 18), moderately unsafe (18 to 26), or unsafe (>26) SAR categories, reaffirming that sodium levels in the studied irrigation water sources are within acceptable agronomic limits. This consistent trend across both tehsils suggests a region-wide low sodium influence on irrigation water quality. The SAR values ranged from 1.32 to 4.47 in the overall Tapi command area, with a mean SAR of 2.44, further supporting the conclusion that the irrigation water poses no significant sodicity risk. Similar results were shown by Aravinthasamy *et al*. (2021) [2] and Sharma *et al*. (2021) [20].

Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) is an important derived parameter used to assess the potential sodium hazard in irrigation water. It considers the combined effects of carbonate and bicarbonate in relation to calcium and magnesium, which can affect soil permeability and structure. High RSC values may lead to soil sodicity and reduced crop productivity. The entire set of 100 samples collected from the Tapi command area, including 50 samples each from Shirpur and Sindkheda tehsils, each, were under the low RSC category (<1.25 meq L^{-1}). This clearly indicates that 100% of the irrigation water samples pose no sodium hazard with respect to residual carbonate content. There were no samples recorded under the moderate (1.25 to 2.50 meq L^{-1}) or unsafe (>2.50 meq L^{-1}) RSC categories. This consistent trend across both tehsils confirms that RSC is not a concern in the irrigation waters of this command area. The overall RSC content for the Tapi command area ranged from 0.00 to 0.00 meq L^{-1}, with an average value of 0.00 meq L^{-1}, which lies far below the critical threshold of 1.25 meq L^{-1} and standard deviation of 0.00, indicating minimal variability. The findings from the current study are similar to Aravinthasamy *et al*. (2021) [2].

Mg^{2+}:Ca^{2+} ratio

The Mg^{2+}:Ca^{2+} ratio is a significant parameter in evaluating the quality of irrigation water, as an excessive proportion of magnesium relative to calcium can deteriorate soil structure and negatively impact plant growth. An ideal balance between these cations is necessary to maintain favorable soil permeability and nutrient uptake. Out of the 100 samples collected from the Tapi command area, none of the samples were under the very low (<0.5) category, indicating that all samples had at least a moderate presence of magnesium relative to calcium. A total of 5% samples (3 from Shirpur and 2 from Sindkheda tehsils) exhibited a low Mg^{2+}:Ca^{2+} ratio (0.5 to 1.0). About 10% samples were categorized as moderate (1.01-1.5), with an even distribution across both tehsils. A significant portion of the samples, 37% in total, werer under the moderately high (1.51 to 2.0) category, indicating an increasing dominance of magnesium over calcium in many parts of the region. Furthermore, 25% samples were categorized as high (2.01 to 2.5), and 23% samples recorded a very high ratio (>2.5), with Shirpur contributing 15 of these very high samples. This trend suggests that a considerable number of samples show magnesium dominance, which could potentially reduce the soil's physical condition and increase sodicity hazards, especially under prolonged use. Similar results were also shown by Subbaiah *et al*. (2020) [22] and Marghade *et al*. (2021) [13] with over 93% of samples classified in the moderately high to very high categories.

Cl^-:SO_4^{2-} ratio

The chloride to sulphate ratio (Cl^-:SO_4^{2-}) is a derived parameter of importance in irrigation water assessment, as an elevated Cl^-:SO_4^{2-} ratio may indicate chloride toxicity, especially for sensitive crops, and can influence salt buildup in soils. Sulphate, on the other hand, tends to form less harmful salts and may somewhat ameliorate chloride-induced hazards. None of the sample in the Tapi command area was under the very low (<0.5) category, confirming that chloride was present in all samples at a significant level relative to sulphate. A total of 15% samples (10 from Shirpur and 5 from Sindkheda tehsils) showed a low ratio (0.5 to 1.0), and 26% samples were under the moderate category (1.01 to 1.5). A larger portion of samples (23%), were categorized under the moderately high class (1.51-2.0), while 19% samples exhibited a high Cl^-:SO_4^{2-} ratio (2.01 to 2.5). Notably, 17% samples (11 from Shirpur and 6 from Sindkheda) were found in the very high category (>2.5), indicating a significant imbalance that could lead to chloride-induced salinity stress in soils and crops. This distribution suggests that while a portion of the irrigation water samples maintain a favorable balance, a substantial fraction of the area experiences elevated chloride dominance, which requires attention. Similar findings were reported by Subbaiah *et al*. (2020) [22] and Rathod *et al*. (2021) [17].

Table 1: Categorization of pH of irrigation water in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample No.	**1-50**	**51-100**	**(% samples)**
Strongly acidic (< 5.5)	0	0	0
Moderately acidic (5.5- 6.5)	0	0	0
Neutral (6.5- 7.5)	24	27	51
Moderately alkaline (7.6 - 8.5)	26	23	49
Strongly alkaline **(**> 8.5)	0	0	0

Table 2: Categorization of electrical conductivity (dS m^{-1}) of irrigation water in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample No.	**1-50**	**51-100**	**(% samples)**
Excellent (< 0.25)	0	0	00
Good (0.25-0.75)	23	29	52
Permissible (0.75-2.25)	27	21	48
Doubtful (2.25-3.00)	0	0	0
Unsuitable (> 3.00)	0	0	0

Table 3: Categorization of SAR of irrigation water in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample No.	**1-50**	**51-100**	**(% samples)**
Safe (< 10)	50	50	100
Moderately safe (10-18)	0	0	0
Moderately unsafe (18-26)	0	0	0
Unsafe (> 26)	0	0	0

Table 4: Categorization of RSC (meq L^{-1}) of irrigation water in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample No.	**1-50**	**51-100**	**(% samples)**
Safe (< 1.25)	50	50	100
Moderate (1.25-2.50)	0	0	0
Unsafe (> 2.50)	0	0	0

Table 5: Categorization of Mg^{2+}:Ca^{2+} in irrigation water in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample No.	**1-50**	**51-100**	**(% samples)**
Very low (< 0.5)	0	0	0
Low (0.5 - 1.0)	3	2	5
Moderate (1.01 - 1.5)	5	5	10
Moderately high (1.51 - 2.0)	14	23	37
High (2.01 - 2.5)	13	12	25
Very high (> 2.5)	15	8	23

Table 6: Categorization of Cl^-:SO_4^- in irrigation water in Tapi command area

Category	Shirpur tehsil	Sindkheda tehsil	Tapi command area
Sample No.	**1-50**	**51-100**	**(% samples)**
Very low (< 0.5)	0	0	0
Low (0.5 - 1.0)	10	5	15
Moderate (1.01 - 1.5)	12	14	26
Moderately high (1.51 - 2.0)	12	11	23
High (2.01 - 2.5)	5	14	19
Very high (> 2.5)	11	6	17

Table 7: Irrigation water quality in Tapi command area

Parameter	Minimum	Maximum	Mean	SD
pH	6.87	8.20	7.59	0.35
EC (dS m^{-1})	0.22	1.28	0.69	0.25
SAR	1.37	4.00	2.43	0.61
RSC (meq L^{-1})	0.00	0.00	0.00	0.00
Mg^{2+}:Ca^{2+}	0.82	4.73	2.15	0.77
Cl^-:SO_4^-	0.60	4.04	1.84	0.83

Conclusion

In Tapi command area, 51% samples were neutral and 49% samples were moderately alkaline. Regarding electrical conductivity, 52% samples were good and 48% samples under permissible limit. The Sodium Adsorption Ratio (SAR) and Residual Sodium Carbonate (RSC) were in safe limit. Possible corrective measures include blending with low-salinity water, gypsum application to counter high carbonate/bicarbonate effects, adopting salt-tolerant crop varieties in affected zones, and practicing leaching to prevent salt accumulation in the root zone.

References

1. Anonymous. Agricultural statistics at a glance. New Delhi (India): Ministry of Agriculture and Farmers Welfare, Government of India; 2020.
2. Aravinthasamy P, Karunanidhi D, Subramani T, Roy PD. Demarcation of groundwater quality domains using GIS for best agricultural practices in the drought-prone Shanmuganadhi River Basin, South India. Environ Sci Pollut Res. 2021;28:18423-18435.
3. Arya S, Subramani T, Vennila G, Karunanidhi D. Health risks associated with fluoride intake from rural drinking water supply and inverse mass balance modeling in the Vattamalaikarai River Basin. Environ Geochem Health. 2021;43(2):705-716.
4. Ayers RS, Westcot DW. Water quality for agriculture. FAO Irrigation and Drainage Paper No. 29. Rome: Food and Agriculture Organization; 1985.
5. Brhane GK. Irrigation water quality index and GIS-based groundwater quality assessment for irrigation purposes in Ganta Afshum, Northern Ethiopia. Int J Emerg Trends Sci Technol. 2016;3(9):4624-4636.
6. Chemura A, Kutywayo D, Chagwesha TM, Chidoko P. Assessment of irrigation water quality and selected soil parameters at Mutema irrigation scheme, Zimbabwe. J Water Resour Prot. 2014;6(2):132-140.
7. Eaton FM. Significance of carbonates in irrigation water. Soil Sci. 1950;69:123-133.
8. Elsayed S, Hussein H, Moghanm FS, Khedher KM, Eid EM, Gad M. Application of irrigation water quality indices and multivariate statistical techniques for surface water quality assessment in the Northern Nile Delta, Egypt. Water. 2020;12(12):3300.
9. Etteieb S, Cherif S, Tarhouni J. Hydrochemical assessment of water quality for irrigation: A case study of the Medjerda River, Tunisia. Appl Water Sci. 2017;7(1):469-480.
10. Gautam SK, Maharana C, Sharma D, Singh AK, Tripathi JK, Singh SK. Evaluation of groundwater quality in the Chotanagpur Plateau region of the Subarnarekha River Basin, Jharkhand, India. Sustain Water Qual Ecol. 2015;6:57-74.
11. Jasmin I, Mallikarjuna P. Evaluation of groundwater suitability for irrigation in the Araniar River Basin, South India using GIS approach. Irrig Drain. 2015;64(5):600-608.
12. Kumawat RK, Singh S, Verma M. Assessment of groundwater quality for irrigation using EC and SAR indices in arid and semi-arid zones of Northwestern India. J Water Soil Resour. 2024;26(2):113-123.
13. Marghade D, Malpe DB, Duraisamy K, Patil PD, Li P. Hydrogeochemical evaluation, suitability, and health risk assessment of groundwater in the Godavari Basin watershed, Maharashtra, Central India. Environ Sci Pollut Res. 2021;28:18471-18494.
14. Mohammad OI, Hassan MF. Evaluation of drainage water quality for irrigation by integration of irrigation water

quality index and GIS. Int J Tech Res Appl. 2016;3(4):24-32.
15. Omran ESE, Ghallab A, Selmy S, Gad AA. Evaluation and mapping of water well suitability for irrigation using GIS in Darb El-Arbaein, Southwestern Desert, Egypt. Int J Water Resour Arid Environ. 2014;3:63-76.
16. Patel RM, Shah SK, Patel RM. Evaluation of groundwater quality for irrigation in the Tapi Basin, Maharashtra using GIS and water quality index. Int J Environ Sci. 2021;12(2):101-110.
17. Rathod H, Vishwanath J, Rudramurthy HV, Veeresh H, Ananda N. Assessment of spatial and temporal changes in salinity and alkalinity of natural stream water in Sindhanur Taluka of Tungabhadra Command Area, Karnataka. J Farm Sci. 2021;34(3):269-277.
18. Richards LA. Diagnosis and improvement of saline and alkali soils. USDA Handbook No. 60. Calcutta (India): Oxford & IBH Publishing Co.; 1954. p. 160.
19. Steube C, Richter S, Griebler C. First attempts towards an integrative concept for the ecological assessment of groundwater ecosystems. Hydrogeol J. 2009;17:23-35.
20. Sharma CM, Kang S, Tripathee L, Paudyal R, Sillanpää M. Major ions and irrigation water quality assessment of Nepalese Himalayan rivers. Environ Dev Sustain. 2021;23:2668-2680.
21. Subba Rao N. Groundwater quality from a part of Prakasam district, Andhra Pradesh, India. Appl Water Sci. 2018;8:30.
22. Subbaiah PV, Naidu MVS, Radha Krishna Y, Kaledhonkar MJ, Meena BL. Groundwater quality assessment for Chittoor district of Andhra Pradesh for irrigation purposes and management options. J Soil Salinity Water Qual. 2020;12(1):1-14.
23. Suresh G, Yadav AK, Meena HK. Salinity and sodicity hazards in irrigation water of major command areas of central India: A quality appraisal. Environ Earth Sci. 2024;83:214.
24. Thilagavathi N, Subramani T, Suresh M. Land use/land cover change detection analysis in Salem Chalk Hills, South India using remote sensing and GIS. Disaster Adv. 2015;8:44-52.