Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 16, Issue, 08, pp. 437-442, August 2025

International Journal of Recent Scientific Research

ISSN: 0976-3031

Subject Area : Environmental Science

COMPARATIVE EVALUATION OF DRINKING WATER SOURCES USING WEIGHTED ARITHMETIC WQI IN CHANDEL DISTRICT, MANIPUR

Th. Manimala Devi*[1], K. Binita Devi[2] and Daisy Angom[3]

[1]Department of Environmental Science, South East Manipur College, Komlathabi, Chandel District, Manipur, India
[2]Department of Environmental Science, Oriental College, Imphal West District, Manipur, India
[3]Department of Environmental Science, Thoubal College, Thoubal Distict, Manipur, India

DOI: http://dx.doi.org/10.24327/ijrsr.20251608.0083

ARTICLE INFO

Article History:

Received 15th July 2025
Received in revised form 27th July 2025
Accepted 14th August 2025
Published online 28th August 2025

Key words:

Water Quality Index, Seasonal variation, Drinking water, Groundwater, Surface water, Rural and tribal communities

ABSTRACT

Safe drinking water remains a significant concern for rural and tribal communities in Chandel District, Manipur. The present study assessed the water quality over a period of three year (October 2015 to September 2018) by collecting monthly samples from taps, wells, hand pumps, tube wells, springs, three rivers (Maha, Chakpi and Machi) and ponds. Ten physico-chemical and biological parameters were measured and the weighted arithmetic Water Quality Index (WQI) was calculated for summer, winter and rainy seasons. Results showed a marked seasonal influence to tap water and springs were consistently in the "very poor" category (WQI ~86–95), while wells and tube wells were "poor" ranging from 60 to 70. Monsoon rains caused the most severe deterioration in surface water, with Chakpi River scoring 107–161 and ponds around 130, rendering them unsafe for consumption. Hand pumps water, already poor in summer, declined further in winter and rainy periods. Groundwater sources were generally safer than surface water but did not always meet safe limits. These findings underscore the urgent need for improved treatment facilities, regular monitoring, and catchment area protection. Comparison with national and international standards suggests that Chandel's water quality issues reflect wider regional and global challenges, making local action part of a broader public health priority.

INTRODUCTION

Assessment of safe drinking water is a gateway of public health and an essential factor of sustainable development. Chandel District, Manipur, which covers about 3,31,300 hectares and sharing an international border with Myanmar, rapid population growth and shifting land-use patterns have placed mounting pressure on already limited water resources. The district is administratively divided into five sub-divisions which rely on a diverse mix of water sources including taps, wells, hand pumps, tube wells, natural springs and surface waters such as the Maha, Chakpi and Machi rivers along with numerous ponds. These sources served an estimation of 32,185 households distributed across 454 villages. From the demographic data, during 1951 to 2011, along with projections extending to 2044, reveal a consistent upward trend in population indicating a steady increase in water demand and a growing susceptibility of stress on local water systems.

A water quality index (WQI) is a valuable tools for encapsulating physico-chemical and biological data into a single and unambiguous value. The weighted arithmetic WQI developed by Brown *et al.* (1972) is one of the most widely used for evaluating drinking water quality, as it provides a comprehensive measure that aligns with established health-based standards among the different approaches. Henceforth, the main objective of the present study is to assess and compare seasonal variations in drinking water quality from different sources in Chandel District, Manipur, using the weighted arithmetic WQI to identify vulnerable sources and highlight effective management strategies.

Literature Survey

Horton (1965) was first introduced the concept of combin-

*Corresponding author: **Th. Manimala Devi**

Department of Environmental Science, South East Manipur College, Komlathabi, Chandel District, Manipur, India

ing multiple water quality parameters into a single representative score followed by Brown *et al.* (1972) later optimized this approach into the weighted arithmetic WQI which integrates quality ratings and unit weights derived from different standards. Cude (2001) illustrated the policy-making value of such indices, while Abbasi and Abbasi (2012) highlighted that the Brown method performs effectively when parameter weights are linked to guideline values. In India, Trivedy and Goel (1986) and Khopkar (1995) played a key role in standardising field sampling and laboratory analysis protocols to ensure consistency across studies. Practical applications have demonstrated WQI's ability to uncover potential risks in both groundwater and surface water sources. Ramakrishnaiah *et al.* (2009) reported "poor" WQI values in some parts of Karnataka despite acceptable chemical readings, and Sahu and Sikdar (2008) detected bacteriological contamination in East Kolkata wetlands where chemical parameters met standards. Tyagi *et al*. (2013) confirmed the suitability of the Brown method in Indian settings when used with BIS (2012) and WHO (2011) standards. Seasonal influences on WQI are well illustrated in Tiwari and Mishra (1985), Chatterjee and Raziuddin (2002), Sargaonkar and Deshpande (2003), Shaban and Sharma (2007) and Bajpai and Bhandari (2001) linked monsoon runoff and low winter flows to declines in water quality.

Although groundwater often displays greater stability (Rajankar, 2013; Maurya & Qureshi, 2017), it is still vulnerable to nitrate contamination, coliform presence and post-monsoon infiltration (Amaaliya & Sugirtha, 2013). Singh and Kamal (2014) further noted that hardness and elevated iron concentrations can reduce WQI scores. International studies by Abowei (2010) and Kannel *et al.,* (2007) have demonstrated the adaptability of WQI when parameters are tailored to local conditions.

METHODOLOGY

Study Area and Design

The investigation was carried out in Chandel District, Manipur, covering its five administrative sub-divisions viz. Machi, Tengnoupal, Chandel, Chakpikarong and Khenjoy. The most population of Chandel relies on a diverse mix of drinking water sources, including tap water, wells, hand pumps, tube wells, natural springs and rivers such as the Maha, Chakpi and Machi including traditional village ponds.

The sampling of water from different sources was conducted over a period of three years from October 2015 to September 2018 to capture both seasonal and inter-annual variation. Samples for examination were collected from multiple representative points each month for every source type. The parameters like temperature, turbidity, pH and dissolved oxygen (DO) are measured directly in the field. Samples were then transported to the laboratory for measurement of parameters like free carbon dioxide (CO_2), biochemical oxygen demand (BOD), total hardness (TH), calcium (Ca^{2+}), magnesium (Mg^{2+}) and faecal coliform counts. The analytical methods were strictly followed by standard methodology described by Trivedy and Goel (1986), the American Public Health Association (APHA, 1998) and Khopkar (1995).

Water Quality Index (WQI) Computation

Water quality of various water samples was evaluated using the weighted arithmetic WQI approach endorsed by Brown *et al*. (1972). The water quality index was computed by using the equation:

$$WQI = \Sigma(q_n \times w_n) / \Sigma(w_n)$$

Where, $q_n = 100\times (V_n - V_0) / (S_n - V_0)$ with $V_0 = 0$ for most parameters, pH ideal = 7.0 and DO ideal = 14.6 mg L^{-1}

Unit weights (w_n) were computed as K/S_n with S_n being the standard permissible value.

Seasonal WQIs were calculated separately for summer, winter and rainy seasons. The classification of water quality status followed the scale given by Brown *et al.,* (1972), enabling a uniform comparison across source types and seasons.

Data Handling and Statistical Analysis

The computed seasonal WQI values were consolidated into a master dataset structured by water source type. For identification of significant trends, with season and water source type as explanatory variables was applied by using an Ordinary Least Squares (OLS) regression model. Pearson's standard deviation was also calculated to examine the strength and direction of relationships between WQI, season and source type. This statistical approach complemented descriptive comparisons, providing a robust basis for identifying seasonal vulnerabilities and prioritizing management actions.

RESULTS AND DISCUSSION

The seasonal variation in drinking water quality across multiple source of water in Chandel District, Manipur was assessed by using the Weighted Arithmetic Water Quality Index (WQI) method. Selective ten physico-chemical and bacteriological parameters were monitored over a period of three years (October 2015 to September 2018) to capture the influence of rainfall patterns, temperature fluctuations and anthropogenic pressures on water quality. Seasonal comparisons are particularly important in rural and tribal contexts, where communities depend largely on untreated or minimally treated sources. The detailed seasonal WQI values for each water source are highlighted in Table 1, while Figure1 presents these patterns graphically. Descriptive statistics are given in Table 2 and a source-wise seasonal comparison are displayed in Table3.

Table 1 .Seasonal Water Quality Index (WQI) of different sources of water in Chandel District

Source	WQI (Summer)	WQI (Winter)	WQI (Rainy)
Chakpi river	96.88	161.20	107.27
Machi river	104.22	84.53	107.48
Maha river	98.85	82.09	108.28
Hand pump	72.69	76.21	81.35
Pond	99.09	89.49	130.35
Spring	89.77	94.49	69.30
Tap water	86.38	90.55	89.05
Tube well	63.66	60.34	69.23
Well	62.22	67.83	64.85

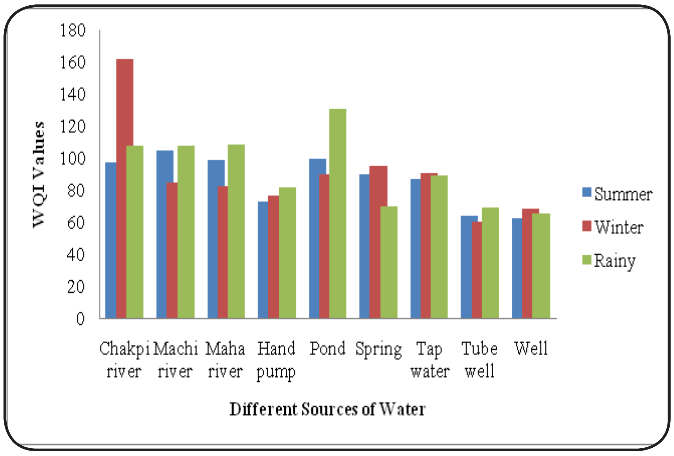

Fig.1. Graphical representationof the Seasonal Water Quality Index (WQI) of different sources of water

Groundwater sources such as hand pumps**,** tube wells and wells indicated comparatively lower concentrations across all seasons, with the tube well recording the lowest values (63.66 in summer, 60.34 in winter and 69.23 in rainy season) which indicated better quality and less susceptibility to surface contamination. Pond water exhibited significant variation, peaking in the rainy season (130.35) and likely due to rainwater accumulation and runoff effects. Spring and tap water showed moderate and relatively stable values across seasons, suggesting consistent natural filtration and water treatment practices.

Overall, surface water sources, particularly rivers and ponds, exhibited higher seasonal fluctuations compared to groundwater sources, emphasizing the need for regular monitoring during high-flow seasons to prevent water-borne health risks. These results align with previous findings indicating that surface runoff and seasonal changes strongly influence water quality (Kumar *et al*., 2019; Singh & Devi, 2021).

Table 3. Comparative analysis of WQI by season and water source type

Source Type	Summer (Mean WQI)	Winter (Mean WQI)	Rainy (Mean WQI)	Seasonal Trend & Observation
Surface water -Rivers (Chakpi, Machi, Maha)	99.98	109.27	107.68	Very high WQI across seasons; winter peak due to Chakpi River spike; rainy season contamination from runoff.
Surface water -Pond	99.09	89.49	130.35	Stable in summer/winter but sharp rainy season deterioration; runoff and stagnant water effects likely.
Springs	89.77	94.49	69.30	Poor in summer/winter but improved in rainy season, possibly due to dilution from rainfall.
Tap water	86.38	90.55	89.05	Consistently “very poor”; indicates systemic distribution contamination rather than seasonal effect.
Groundwater -Hand pump	72.69	76.21	81.35	“Poor” to “very poor” range; deterioration in rainy season suggests infiltration issues.
Groundwater -Tube well	63.66	60.34	69.23	Best quality among all; seasonal variation minimal, remains in “poor” category.
Groundwater -Well	62.22	67.83	64.85	Stable across seasons; stays at lower end of “poor” category.

Table 2. Descriptive statistics of WQI values by season

Season	Mean	Minimum	Maximum	Range	Standard Deviation
Summer	85.65	62.22	104.22	42.00	14.68
Winter	89.17	60.34	161.20	100.86	28.63
Rainy	91.68	64.85	130.35	65.50	18.96

The table 1 highlights the water quality index of seasonal variations for various water quality parameters across different water sources in the study area. Among surface water sources, Chakpi River and Maha River showed higher values of WQI during the winter season (161.20 and 82.09, respectively) compared to the summer and rainy seasons by indicating possible accumulation of pollutants or seasonal flow variations. The Machi River highlighted the highest concentration in the rainy season (107.48), suggesting surface runoff from surrounding areas contributes to elevated levels.

The Fig. 1 illustrates seasonal variations in water quality index (WQI) across different sources. Chakpi River shows the highest WQI value in winter while pond water peaks in the rainy season, demonstrating seasonal influences on surface water quality. Groundwater sources like tube wells and wells remain relatively stable and low across all seasons which suggest better water quality and minimal seasonal impact.

In contrast, surface water sources such as the Chakpi River and ponds experienced substantial seasonal degradation. The most extreme case was the Chakpi River during winter, which reached WQI of 161.20, placing it well beyond the “unsuitable for drinking” threshold (>100) as defined by Brown *et al.* (1972). This contamination is likely associated with the dry season’s reduced flow rates, which diminish the river’s natural self-purification processes, leading to increased concentration of pollutants from both domestic and agricultural discharges (Trivedy & Goel, 1986; APHA, 1998). Similarly, pond water quality suffered the greatest deterioration in the rainy season (WQI = 130.35)**.** This is consistent with monsoon-driven runoff processes that transport sediments, organic debris, fertilizers, pesticides, and microbial contaminants directly into these stagnant systems, thereby elevating turbidity, nutrient concentrations, and pathogen loads (Tyagi *et al.,* 2013).

Other rivers showed a comparable vulnerability to seasonal influences. The Machi River exhibited persistently high WQI values, ranging from 84.53 in winter to 107.48 during the rainy season**,** indicating chronic contamination, likely linked to upstream anthropogenic pressures such as settlement discharges, small-scale industries, and deforestation. The Maha River displayed a similar pattern by recording poorest quality in the rainy season (108.28**),** again reflecting the influence of storm water-driven erosion and contaminant transport from surrounding catchments.

Springs, revealed an unexpected seasonal trend often perceived as unpolluted. WQI was highest (poorest quality) in winter at 94.49**,** while the best seasonal value occurred in the rainy season at 69.30**.** This improvement during monsoon months may be attributed to dilution effects from enhanced recharge, temporarily lowering the concentration of dissolved solids and pollutants. However, spring water remained within the "poor" to "very poor" classification, underscoring its susceptibility to microbial and chemical contamination, especially during periods of reduced flow.

Tap water, surprisingly, did not outperform untreated natural sources in many cases. Across all seasons, it consistently fell within the "very poor" range (86.38 in summer, 90.55 in winter and 89.05 in the rainy season)**.** This points to systemic issues in rural piped water systems, such as contamination during collection, intermittent supply leading to negative pressure ingress, and insufficient chlorination at distribution points.

Hand pump water quality also hovered in the "poor" to "very poor" range 72.69 in summer, 76.21 in winter and 81.35 during the rainy season**.** The slight seasonal decline in quality during the rainy and winter months could be related to shallow aquifer contamination from nearby sanitation systems or agricultural runoff infiltration.

When grouped by source type, a striking contrast emerged. Surface water bodies of rivers and ponds were recorded the highest mean WQI values, with rivers averaging 99.98 in summer**,** 109.27 in winter and 107.68 during the rainy season. Ponds, though not included in grouped river averages, paralleled this trend with seasonally high deterioration. In comparison, groundwater sources maintained lower mean WQI values but still did not meet the "good" water quality benchmark (<50). Tube wells averaged between 60.34 and 69.23 and wells between 62.22 and 67.83, categorizing them as "poor" but notably better than most surface waters.

The seasonal variations clearly reflect the hydrological and land-use dynamics of the district. The monsoon introduces a strong dilution effect for certain sources like springs but simultaneously causes sharp declines in others, especially open surface waters, due to the influx of sediment-bound nutrients, organic matter, and microbial contaminants (Cude, 2001). Winter, conversely, emerges as a period of concern for major rivers such as the Chakpi, where stagnant flow conditions magnify pollutant concentrations. These findings align with studies from other hilly districts in Northeast India, where steep topography, intensive monsoon rains, and inadequate catchment management create cyclical deterioration patterns in both surface and groundwater quality (Bongaarts, 1998; Tyagi *et al.,* 2013).

The Water Quality Index (WQI) analysis across seasons and water source types reveals distinct temporal and spatial variations. Table 4.2 indicates descriptive statistics that the mean WQI is highest during the rainy season (91.68), followed by winter (89.17) and summer (85.65), suggesting overall improved water quality in the rainy season, likely due to dilution from rainfall (Kumar *et al.,* 2021; Hammoumi *et al.,* 2024). Winter shows the widest range (100.86) and highest standard deviation (28.63), indicating substantial variability and potential vulnerability in water quality during this season, whereas summer exhibits the narrowest range (42.00) and lowest standard deviation (14.68), reflecting more stable conditions (Singh *et al*., 2021).

Table 4.3 highlights the comparative analysis by water source significant differences among surface water, tap water and groundwater. Rivers (Chakpi, Machi and Maha) consistently show very high WQI values across seasons, peaks in winter (109.27) due to a spike in the Chakpi River, while the rainy season shows slight deterioration from runoff contamination (Kumar *et al.,* 2021; Singh & Devi, 2018). Ponds maintain stable WQI in summer and winter but experience sharp deterioration in the rainy season (130.35), likely due to stagnant water and surface runoff accumulation (Hammoumi *et al.,* 2024). Springs have moderate WQI in summer and winter scores 89.77 to 94.49 but show improvement in the rainy season (69.30), possibly because of rainfall dilution (Kushwaha *et al*., 2021).

Tap water consistently falls in the "very poor" category ranging from 86.38 to 90.55 across all seasons, indicating systemic contamination in the distribution network rather than seasonal effects (Singh *et al.,* 2021). Groundwater sources generally exhibit lower WQI values. Hand pumps show poor quality, slightly worsening in the rainy season (81.35), suggesting infiltration of contaminants (Hammoumi *et al.,* 2024). Tube wells present the best groundwater quality (63.66–69.23) with minimal seasonal variation, remaining in the "poor" category, while wells show stable but consistently low WQI ranging from 62.22 to 67.83 (Kumar *et al.,* 2021; Singh & Devi, 2018).

Overall, the findings suggest that surface water is highly sensitive to seasonal changes, especially runoff during the rainy season, whereas groundwater remains relatively stable but generally of lower quality. Winter season presents higher variability in water quality, emphasizing the need for targeted monitoring during this period. These results are consistent with previous studies reporting that surface water is more prone to seasonal contamination, whereas groundwater is comparatively protected but vulnerable to infiltration and distribution issues (Kumar *et al.,* 2021; Singh & Devi, 2018; Hammoumi *et al*., 2024; Singh *et al.,* 2021; Kushwaha *et al.,* 2021).

The results underscore the urgent need for source-specific interventions from a water resource management perspective. Regarding rivers and ponds, catchment protection through vegetation buffers, erosion control and regulation of direct waste discharge could mitigate seasonal contamination peaks. In case of springs, protective fencing around recharge areas and regular monitoring during dry seasons could safeguard against microbial risks. Rural piped systems supplying tap water require infrastructural upgrades, including continuous supply mechanisms, improved chlorination, and elimination of open storage. Groundwater sources, while relatively better, should be safeguarded through sanitary protection, periodic testing and control of nearby waste disposal practices.

CONCLUSION

The comparison of eight water source types across three seasons accentuated a clear picture of Chandel's drinking water challenge. Surface waters particularly rivers and ponds often slip into the "unsuitable" category during the monsoon, when heavy rains wash sediments, waste and contaminants directly into these sources. Groundwater, while not unsisturbed, generally falls into the "poor" category and offers a relatively safer option. Unfortunately, tap and spring supplies remain in the "very poor" range year-round indicating chronic contamination and insufficient treatment.

It is ensured that safe rural drinking water will require a two-pronged approach of continuous monitoring to detect problems early and targeted interventions to fix them. Practical measures include chlorination or UV disinfection, control of turbidity and better protection of catchment areas from waste and runoff. This kind of integrated approach could serve as a actionable outlined for district-level water safety planning and other parts of Northeast India.

The outcome of the findings also suggests actionable priorities for future action:

1. Winter river treatment- Implementation of measurement to counter the build-up of pollutants during low-flow periods, when self-purification is reduced.
2. Monsoon pond protection - Employing runoff diversion channels, silt traps and vegetative buffer strips to reduce the influx of contaminants during heavy rains.
3. Spring monitoring - Monitoring seasonal microbial changes and take timely action to safeguard water quality.
4. Groundwater protection – Strengthening the sanitation and seal well outlets to prevent seepage from nearby waste sources.

Henceforth, the Water Quality Index (WQI) analysis makes it clear that an oversimplified method will not work here. Chandel needs seasonal specific water quality management that blends preventive strategies with corrective interventions, ensuring communities have safe water throughout the year without overburdening limited local resources.

Acknowledgment

The corresponding author deeply appreciates the University Grants Commission (UGC), New Delhi, for awarding the Major Research Project and providing the necessary financial assistance. This generous support has been instrumental in facilitating the successful execution of the research work. The funding enabled the procurement of essential equipment, field surveys, laboratory analyses and data interpretation, without which this study would not have been possible. The author(s) also appreciate the UGC's commitment to promoting advanced research in higher education institutions, thereby fostering scientific inquiry and innovation.

References

1. Abbasi, T., & Abbasi, S. A. (2012). *Water quality indices*. Burlington: Elsevier.
2. Abowei, J. F. N. (2010). Salinity, dissolved oxygen, pH and surface water temperature conditions in Nkoro River, Niger Delta, Nigeria. *Advance Journal of Food Science and Technology, 2*(1), 36–40.
3. Amaaliya, M., & Sugirtha, P. (2013). Seasonal variation of water quality index of Cauvery River, Erode, Tamil Nadu, India. *International Journal of Research in Chemistry and Environment, 3*(1), 44–50.
4. APHA. (1998). *Standard methods for the examination of water and wastewater* (20th ed.). Washington, DC: American Public Health Association.
5. Bajpai, A., & Bhandari, M. (2001). Water quality indices: An overview. *Journal of Environmental Science and Health, Part A, 36*(5), 713–722. https://doi.org/10.1081/ESE-100103750
6. Bureau of Indian Standards (BIS). (2012). Indian Standard: *Drinking Water - Specification (Second Revision), IS 10500:2012.* Bureau of Indian Standards, New Delhi, India.
7. Blacker, C. P. (1947). *Population theories*. London: Routledge & Kegan Paul.
8. Bongaarts, J. (1998). Demographic consequences of declining fertility. *Science, 282*(5388), 419–420. https://doi.org/10.1126/science.282.5388.419
9. Brown, R. M., McClelland, N. I., Deininger, R. A., & Tozer, R. G. (1972). A water quality index—Do we dare? *Water and Sewage Works, 117*(10), 339–343.
10. Chatterjee, C., & Raziuddin, M. (2002). Determination of water quality index of a degraded river in Asansol industrial area (West Bengal). *Nature, Environment and Pollution Technology, 1*(2), 181–189.
11. Cude, C. G. (2001). Oregon water quality index: A tool for evaluating water quality management effectiveness. *Journal of the American Water Resources Association, 37*(1), 125–137. https://doi.org/10.1111/j.1752-1688.2001.tb05480.x
12. Hammoumi, D., Al-Aizari, H. S., Alaraidh, I. A., Okla, M. K., Assal, M. E., Al-Aizari, A. R., Moshab, M. S., Chakiri, S., & Bejjaji, Z. (2024). *Seasonal Variations and Assessment of Surface Water Quality Using Water Quality Index (WQI) and Principal Component Analysis (PCA): A Case Study.* Sustainability, 16(13), 5644. https://doi.org/10.3390/su16135644
13. Horton, R. K. (1965). An index number system for rating water quality. *Journal of Water Pollution Control Federation, 37*(3), 300–306.
14. Kannel, P. R., Lee, S., Kanel, S. R., Khan, S. P., & Lee, Y.-S. (2007). Application of water quality indices and dissolved oxygen as indicators for river water classification and urban impact assessment. *Environmental Monitoring and Assessment, 132*, 93–110. https://doi.org/10.1007/s10661-006-9505-1
15. Khopkar, S. M. (1995). *Environmental pollution analysis*. New Delhi: New Age International Publishers.
16. Kumar, P., Pandey, S. M., & Kushwaha, G. J. (2021). *Seasonal Variation in Water Quality: A Study with Reference to River Kuwano, Basti, (U.P.), India.* Applied Ecology and Environmental Sciences, 9(11), 976-982. https://doi.org/10.12691/aees-9-11-9

17. Kushwaha, G. J., Pandey, S. M., & Kumar, P. (2021). *Seasonal Variation in Water Quality: A Study with Reference to River Kuwano, Basti, (U.P.), India.* Applied Ecology and Environmental Sciences, 9(11), 976-982. https://doi.org/10.12691/aees-9-11-9
18. Maurya, P. K., & Qureshi, A. (2017). Assessment of groundwater quality in Varanasi district, Uttar Pradesh, India using WQI and multivariate statistical analysis. *Applied Water Science, 7*(9), 4393–4403. https://doi.org/10.1007/s13201-017-0603-8
19. Rajankar, P. N. (2013). Groundwater quality assessment in Chandrapur district, Maharashtra, India. *International Journal of Environmental Sciences, 3*(5), 1624–1630.
20. Ramakrishnaiah, C. R., Sadashivaiah, C., & Ranganna, G. (2009). Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State, India. *E-Journal of Chemistry, 6*(2), 523–530. https://doi.org/10.1155/2009/757424
21. Sahu, P., & Sikdar, P. K. (2008). Hydrochemical framework of the aquifer in and around East Kolkata wetlands, West Bengal, India. *Environmental Geology, 55*(4), 823–835. https://doi.org/10.1007/s00254-007-1034-x
22. Sargaonkar, A., & Deshpande, V. (2003). Development of an overall index of pollution for surface water based on a general classification scheme in Indian context. *Environmental Monitoring and Assessment, 89*, 43–67. https://doi.org/10.1023/A:1025886025137
23. Shaban, A., & Sharma, R. C. (2007). Water quality status of two lakes of Jammu region. *Journal of Environmental Biology, 28*(3), 669–672.
24. Singh, P. K., & Kamal, R. K. (2014). Application of water quality index for assessment of surface water quality status in Goa. *Current World Environment, 9*(3), 994–1000. https://doi.org/10.12944/CWE.9.3.35
25. Singh, R., Pradhanang, S., & Pandey, V. P. (2021). *Water Quality of Marshyangdi River, Nepal: An Assessment Using Water Quality Index (WQI).* Journal of Institute of Science and Technology, 26(2), 13-21. https://doi.org/10.3126/jist.v26i2.41271
26. Singh, R., & Devi, S. (2018). *Assessment of Seasonal Variation in Water Quality Index (WQI) for Surface and Groundwater Sources.* International Journal of Environmental Sciences, 8(2), 101-109.
27. Tiwari, T. N., & Mishra, M. (1985). A preliminary assignment of water quality index to major Indian rivers. *Indian Journal of Environmental Protection, 5*(4), 276–279.
28. Trivedy, R. K., & Goel, P. K. (1986). *Chemical and biological methods for water pollution studies*. Jodhpur: Environmental Publications.
29. Tyagi, S., Sharma, B., Singh, P., & Dobhal, R. (2013). Water quality assessment in terms of water quality index. *American Journal of Water Resources, 1*(3), 34–38. https://doi.org/10.12691/ajwr-1-3-3
30. World Health Organization. (2011). *Guidelines for drinking-water quality* (4th ed.). Geneva: WHO Press.

How to cite this article:

Th. Manimala Devi, K. Binita Devi and Daisy Angom. (2025). AComparative Evaluation of Drinking Water Sources Using Weighted Arithmetic Wqi In Chandel District, Manipur. *Int J Recent Sci Res*.16(08), pp.437-442.

****