



Assessment of Subsurface water Contamination in Coastal Part of Andhra Pradesh

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KEYWORDS

Subsurface water quality, Physico-chemical parameters, Sodium Absorption Ratio (SAR) method, Coastal zone, Residual Sodium Content (RSC).

ABSTRACT:

The use of subsurface water for various purposes is steadily increasing across the globe. With this growing reliance, the prevention of contamination and effective management of subsurface water resources have become essential—especially given their limited availability in many regions. In this context, a comprehensive study was carried out to evaluate the groundwater quality in Jadavalli village, situated in Ponnur Mandal of Guntur district, Andhra Pradesh. The study area is geologically characterized by clay and sand deposits from the Recent era, with groundwater occurring under unconfined conditions. The groundwater was evaluated based on several physico-chemical parameters, many of which were found to exceed the standard limits for drinking water. Additionally, analyses using Residual Sodium Carbonate and Sodium Absorption Ratio methods revealed that the groundwater is unsuitable for irrigation purposes. This study aims to understand the geochemical processes influencing subsurface water quality and proposes appropriate precautionary measures to enhance and protect groundwater quality in the region.

1. Introduction

Water is one of the most vital assets for sustaining life, supporting ecosystems, and supporting agricultural and industrial activity. Groundwater is often the primary supply of freshwater in coastal areas, in areas where surface water supplies are few or overexploited. The coastal portions of Andhra Pradesh, a state in southern India, are no exception. Such areas rely fully on subterranean water for drinking, irrigation, and household purposes. However, getting human pressures, such as rapid urbanization, agricultural intensification, and industrial growth, have resulted in a major decline in groundwater quality. In coastal areas, seawater intrusion exacerbates the problem by raising salinity levels and changing the chemical makeup of groundwater. Subsurface water quality must be checked and studied in such sensitive areas to ensure its long-term viability and safety. The purpose of this study is to assess the pollution levels of subsurface water in Andhra Pradesh's coastal region using major physicochemical criteria. Indices such as the SAR & RSC are particularly important in determining groundwater suitability for agricultural use. The findings of this assessment will enhance our understanding of groundwater quality in the region and support informed decision-making in water resource management and policy planning.

The demand for subsurface water has significantly increased in both rural and urban regions across the globe. As a result, the proper maintenance and

management of subsurface water quality have become essential—not only for economic development but also for environmental sustainability. Water contamination in coastal zones can occur due to factors such as marine transgressions and regressions, as well as the use of fertilizers in agriculture (Sheryl et al., 1994; Purandara B.K. et al., 2004; Tole M.P., 1997; Sinton L.W., 1986; Mustafa W. et al., 1999; Alfred P. Bernhart, 1973; APHA, 1998; Venkata Ramana R., Shriparna Saxena et al., 2002).

2. Study Location

The study area of Jadavalli village is located to the south of Ponnur Mandal, positioned between 80.57611° E longitude and 16.031580° N latitude, as shown in the enclosed map (Fig. 1). The study area lies on the eastern side of the Tungabhadra drain.

2.1 Physiography:

The study area is predominantly flat, with a gentle slope extending toward the Bay of Bengal. Portions of the natural drainage pattern have been modified into irrigation channels and drainage systems. Land use in the region comprises approximately 95% agricultural land, 4% residential or domestic land, and 1% wasteland.

2.2 Hydrogeology:

The area is predominantly composed of clay, sand, and silt deposits from the Recent era. Around Jadavalli village, the study area features permeable coarse to medium sand layers. These sandy deposits extend to



depths ranging from 12 to 25 meters and are underlain by thick clay layers, where the groundwater quality tends to be saline. Freshwater is found within the sandy aquifers along paleo-channels and exists under unconfined conditions (CGWB Report). Groundwater is

primarily extracted through shallow filter points for irrigation purposes. The water table depth ranges between 2.9 and 3.7 m below ground level, and the thickness of the alluvial sands varies from 10 to 27 m.

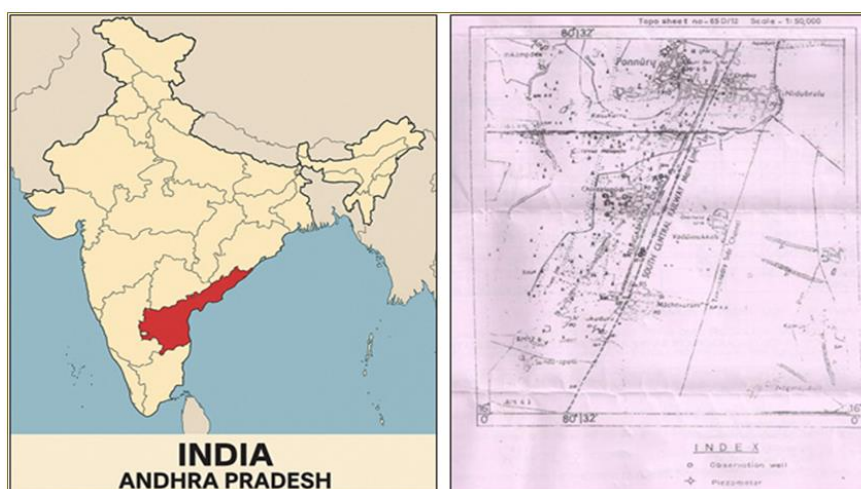


Figure 1: Location Map

3. Quality Studies

The quality of irrigation water is key to soil health and long-term agricultural output. Among a few water quality indicators, the Sodium Absorption Ratio (SAR) and Residual Sodium Content (RSC) are extensively used to assess water suitability for agricultural use. They also aid in assessing the possible influence of salt on soil structure and crop output. The Sodium Absorption Ratio (SAR) is a measure of the proportion of sodium ions to calcium and magnesium ions in water. High SAR values can cause soil dispersion, bound permeability, and unfit infiltration, reducing growth of plants. Residual Sodium Content (RSC) refers to the surplus carbonate and bicarbonate ions that might react with calcium and magnesium, lowering their availability and raising sodium danger in the soil. Monitoring SAR and RSC is critical in coastal and agriculturally active areas, such as Andhra Pradesh's coastal belt, because of the simultaneous stresses of heavy irrigation and salty water incursion. The purpose of this study is to measure the levels of SAR and RSC

in subsurface water in order to establish its appropriateness for irrigation and give insights into long-term water management plans.

preliminary hydrogeological investigations conducted in Jadavalli indicate a significant deterioration in groundwater quality in recent years. This decline is particularly noticeable in areas located closer to the Tungabhadra drain. In light of this issue, chemical analysis data of subsurface water samples from the year 1973, as reported by APSGWB (1973), has been compared with the average values of fourteen subsurface water samples collected in various directions from Jadavalli village during the post-monsoon period (Nov. 2024) and the pre-monsoon period (May 2024). The comparative analysis, highlighting average values from both pre-monsoon and post-monsoon samples, is presented in Table 1 and Table 2 below. And graphical representation of subsurface water samples during pre and post-monsoon has been shown in Figure 2 and Figure 3.

Table 1: Analysis details of subsurface water samples in Jadavalli Village during pre-monsoon (in meq/l)

Sl.No.	Chemical Parameter	Jadavalli (Pre monsoon)	
		1973	2024
1	pH	7.64	8.199
2	E.C (micro siemons/cm)	1.94	2.59
3	CO ₃ (meq/l)	0.65	2.46
4	HCO ₃	8.87	6.39
5	Cl	8.36	17.89
6	SO ₄	4.04	7.03



7	Ca ²⁺	3.52	2.29
8	Mg	3.68	3.19
9	Na ⁺	13.80	43.49
10	K ⁺	0.13	0.28
11	Residual Sodium Content	1.32	3.4
12	Sodium Absorption Ratio	7.27	26.21

Table 2: Analysis details of subsurface water samples in Jadavalli Village during Post-monsoon (in meq/l)

Sl.No.	Chemical Parameter	Jadavalli (Post monsoon)	
		1973	2024
1	pH	7.64	8.49
2	E.C (micro siemons/cm)	1.94	2.69
3	CO ₃ (meq/l)	0.65	2.55
4	HCO ₃	8.87	6.49
5	Cl	8.36	13.95
6	SO ₄	4.04	7.4
7	Ca ²⁺	3.52	2.21
8	Mg	3.68	3.4
9	Na ⁺	13.80	45.89
10	K ⁺	0.13	0.69
11	Residual Sodium Content	1.32	3.7
12	Sodium Absorption Ratio	7.27	27.69

Table 3: Classification of subsurface water samples based on values of Residual Sodium Content and Sodium Absorption Ratio

Sl. No.	Parameter	Range	Category
1	Sodium Absorption Ratio	<10	Excellent
		10-18	Good
		18-26	Fair
		>26	Unsuitable
	Residual Sodium Content	<1.25	Safe
		1.25- 2.5	Suitable
		>2.5	Unsuitable

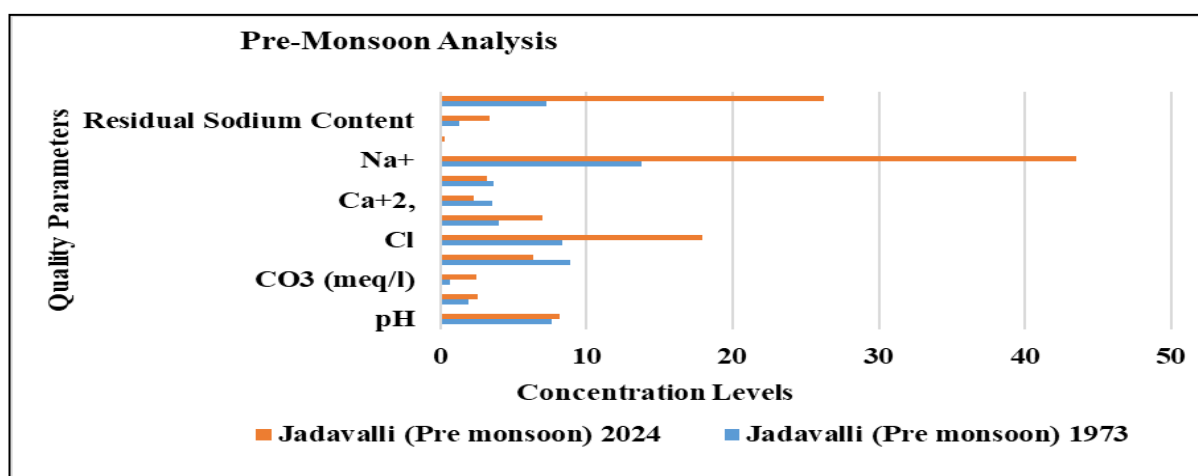


Figure 2. Graphical representation of subsurface water samples during pre-monsoon

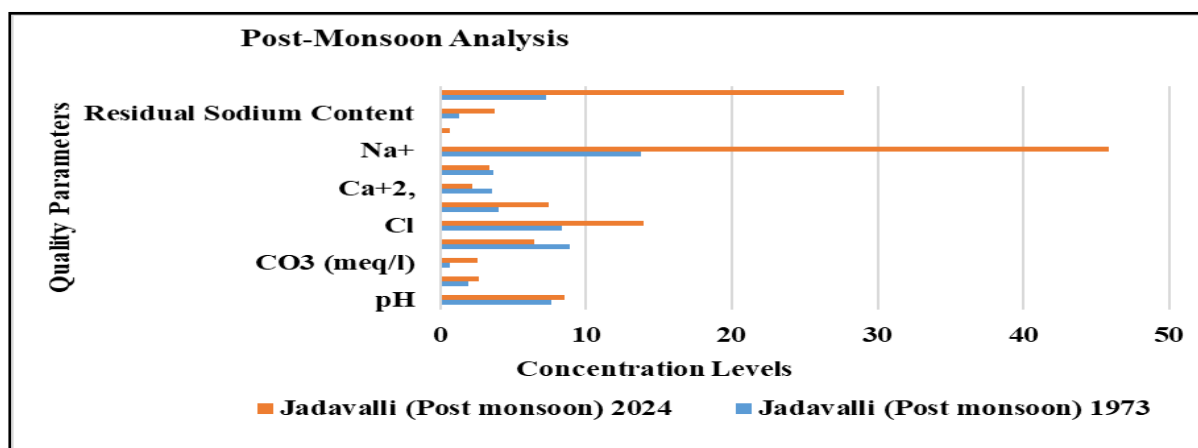


Figure 3. Graphical representation of subsurface water samples during post-monsoon

As observed from Table 1 and Table 2, the Residual Sodium Carbonate (RSC) value of groundwater in the Jadavalli area was 1.32 in 1973. In comparison, the RSC values during the pre-monsoon (May 2024) and post-monsoon (Nov. 2024) periods range between 3.39 and 3.68. An RSC value exceeding 2.5 is indicative of significant seawater contamination, rendering the groundwater unsuitable for irrigation purposes. Therefore, the RSC value of 1.32 recorded in 1973 suggests that the groundwater was not contaminated at that time. However, the elevated RSC values recorded in 2024 clearly point to injurious levels of seawater intrusion, confirming that the groundwater in Jadavalli is now unsuitable for irrigation, as supported by the data in Table 2.

It is further observed from Table 1 and Table 2 that the Sodium Absorption Ratio (SAR) of groundwater in the Jadavalli area was 7.27 in 1973. In contrast, the SAR values during the pre-monsoon (May 2024) and post-monsoon (November 2024) periods range between 26.18 and 27.75. An SAR value exceeding 26 indicates significant seawater contamination, rendering the groundwater unsuitable for irrigation. The low SAR value of 7.27 in 1973 suggests that the groundwater was free from contamination at that time. However, the elevated SAR values recorded in 2024 clearly indicate severe contamination, likely due to seawater intrusion, making the water unsuitable for agricultural use, as shown in Table 3.

The deterioration in groundwater quality in the region may be attributed to the increased extraction of groundwater through filter points, which may have led to the ingress of backwater from the Tungabhadra drain. The number of filter points in the Jadavalli area has risen significantly, reaching a total of 420.

4. Conclusion

It is concluded that the deterioration of subsurface water quality in Jadavalli village, particularly in areas closer

to the Tungabhadra drain, is primarily due to the ingress of backwater from the drain and the over-extraction of groundwater through filter points for irrigation. To prevent further degradation of groundwater quality, the following measures are recommended:

- Groundwater extraction should be strictly regulated and continuously monitored.
- Artificial recharge structures such as recharge wells and ponds should be constructed in contaminated zones.
- Check dams should be built to enhance groundwater recharge in the region.
- The Groundwater Department should establish and maintain observation wells throughout the study area to regularly monitor subsurface water quality.

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