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Spatial Assessment of Groundwater Quality Parameters in Musiri Block: Implications for Sustainable Water Resource Management

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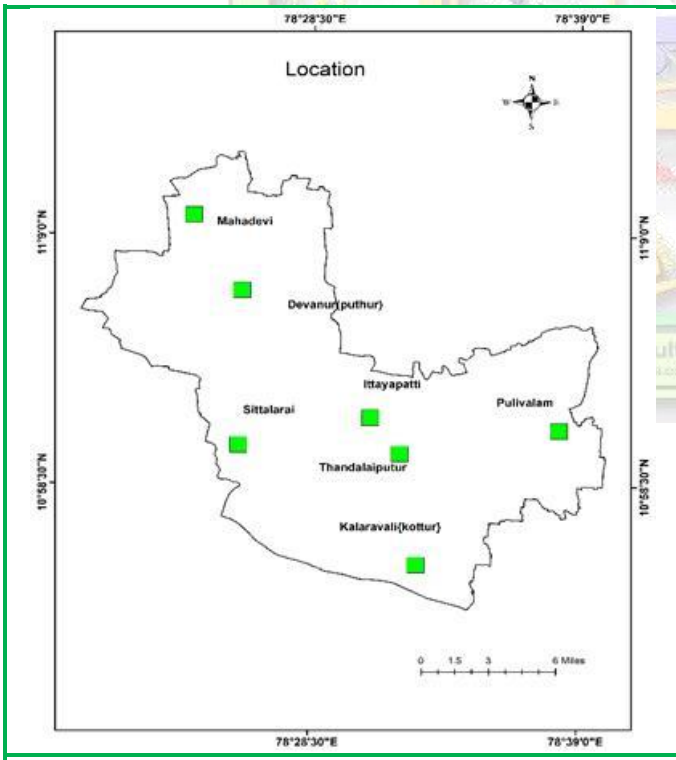
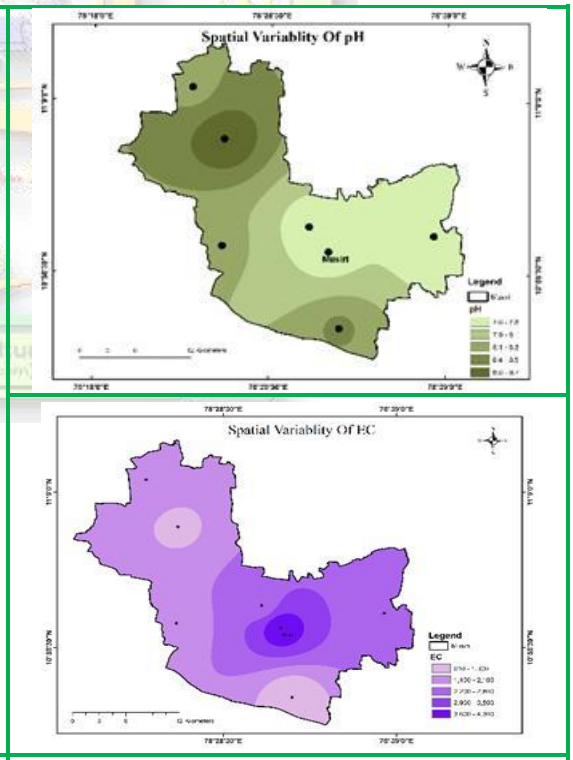
This study presents a comprehensive analysis of groundwater quality parameters across seven villages in Musiri Block, Tamil Nadu, India. The investigation focused on pH and electrical conductivity (EC) variations, revealing significant spatial heterogeneity in groundwater characteristics. Results indicate pH values ranging from 7.6 to 8.7 and EC measurements varying from 610 to 4270 µS/cm, suggesting diverse hydro geochemical conditions across the study area. Groundwater quality assessment is crucial for sustainable water resource management, particularly in semi-arid regions where groundwater serves as a primary water source. This study examines the spatial variability of key water quality parameters in Musiri Block, providing essential data for evidence-based water management decisions.

Study Area

The investigation encompassed seven villages within Musiri Block, located in Tamil Nadu, India. The study sites include:



Sample Location



Spatial Variability Of pH &EC

Data Collection

Groundwater samples were collected from representative wells in each village. The data were collected from PWD Government of Tamilnadu. Standard protocols were followed for sample collection, preservation, and analysis. Parameters measured included: pH (hydrogen ion concentration),Electrical Conductivity (EC)

Table 1: Summary Statistics of Groundwater Quality Parameters

Parameter	Minimum	Maximum	Mean	WHO Standard*
pH	7.6 (Pulivalam)	8.7 (Devanur)	8.0	6.5-8.5
EC (µS/cm)	610 (Kalaravali)	4270 (Thandalaiputur)	2031.4	< 1500

Based on WHO standards shown in Table 1, here are two key points:

The pH levels according to WHO standards should be maintained between 6.5-8.5 for safe drinking and irrigation purposes, as this range ensures optimal chemical balance and prevents corrosion or scaling in water distribution systems while supporting healthy plant growth in agricultural applications.The Electrical Conductivity (EC) as per WHO guidelines should be below 1500 µS/cm for drinking water quality, as higher values indicate excessive dissolved solids that can affect water taste, crop yields, and potentially harm human health through elevated mineral content in drinking water.

Table 2: Village-wise Distribution of Groundwater Quality Parameters

Village Name	Latitude	Longitude	pH	EC (µS/cm)	Quality Zone*
Devanur (Puthur)	11°06'40"N	78°25'45"E	8.7	1140	Moderate
Ittayapatti	11°01'21"N	78°30'50"E	7.7	2340	Poor
Kalaravali	10°55'10"N	78°32'40"E	8.3	610	Good
Mahadevi	11°09'50"N	78°23'50"E	8.2	1860	Moderate
Pulivalam	11°00'50"N	78°38'15"E	7.6	2480	Poor
Sittalarai	11°00'10"N	78°25'40"E	8.1	1520	Moderate
Thandalaiputur	10°59'50"N	78°32'00"E	7.7	4270	Poor

Quality Zone Classification:

- Good: EC < 1500 µS/cm
- Moderate: EC 1500-2500 µS/cm
- Poor: EC > 2500 µS/cm

Table 3: Water Quality Classification Based on EC Values

Quality Zone	EC Range (µS/cm)	Villages	Management Priority
Good	< 1500	Kalaravali, Devanur	Regular Monitoring
Moderate	1500-2500	Sittalarai, Mahadevi	Enhanced Monitoring
Poor	> 2500	Thandalaiputur, Pulivalam, Ittayapatti	Immediate action Require

Table 4: Water Quality Zones Classification and Management Requirements in Musiri Block

Quality Zone	EC Range (µS/cm)	Villages	Characteristics	Management Requirements	Recommended Uses
High-Quality	< 1500	Kalaravali (610 µS/cm)	Low dissolved solids Good water quality Minimal treatment needs	Regular monitoring Preventive maintenance Quality preservation measures	Drinking water (with basic treatment) All agricultural uses Industrial applications

Moderate-Quality	1500-2500	Devanur (1140 µS/cm) Sittalarai (1520 µS/cm) Mahadevi (1860 µS/cm)	Moderate dissolved solids Acceptable for most uses Requires standard treatment	Regular quality monitoring Moderate intervention Periodic treatment assessment Implementation of control measures	Drinking with appropriate treatment Most agricultural uses Industrial use with treatment
Priority Intervention	> 2500	Thandalaiputur (4270 µS/cm) Pulivalam (2480 µS/cm)	High dissolved solids Limited use applications Requires extensive treatment	Immediate management intervention Enhanced treatment systems Continuous monitoring Remediation planning	Limited agricultural use Industrial use with extensive treatment Drinking requires advanced treatment

Table 5: Zone-specific Management Action Plan

Zone Type	Short-term Actions	Medium-term Actions	Long-term Actions
High-Quality	Baseline quality monitoring Protection of water sources Community awareness	Development of protection strategies Implementation of monitoring systems Source sustainability assessment	Aquifer protection programs Sustainable usage policies Long-term preservation planning
Moderate-Quality	Regular quality assessment Basic treatment implementation Usage guidelines development	Treatment facility upgrades Water quality improvement programs User awareness campaigns	Comprehensive management plans Infrastructure development Quality enhancement programs

Technical Interventions

1. Monitoring Systems
   - Implementation of automated quality monitoring networks
   - Regular sampling and analysis protocols
   - Real-time data logging systems
2. Treatment Infrastructure
   - Village-specific treatment facility design
   - Installation of appropriate filtration systems
   - Regular maintenance protocols

Policy Recommendations

1. Regulatory Framework
   - Development of village-specific water quality standards
   - Implementation of groundwater extraction regulations
   - Establishment of monitoring guidelines
2. Resource Management
   - Aquifer mapping and protection

- Recharge zone identification and protection
- Sustainable extraction policies

Conclusion

The spatial variability in groundwater quality parameters across Musiri Block necessitates a differentiated approach to water resource management. The findings support the development of location-specific interventions and policy measures to ensure sustainable groundwater utilization.

Recommendations for Future Research

1. Extended temporal monitoring of quality parameters
2. Investigation of additional hydrochemical parameters
3. Assessment of anthropogenic influences on groundwater quality
4. Development of predictive models for quality variations