A Geographical Study Of Wells In Selected Villages Of Ponda Taluka In Goa

Miss. Siya Shet[1], Mr. Santosh Ghadi[2] & Dr. P.K Rath[3]

[1]*PG Geography Dissertation student &*
[2]*Asst. Prof. of Geography & Research Scholar (Goa University)*
[3]*Professor of Geography (Goa University)*
Corresponding Author – Miss. Siya Shet
DOI - 10.5281/zenodo.18490625

Abstract:

The domestic wells is a lifeline and source of drinking and household water in the villages of Ponda taluka of Goa. There is increasing threat and concern towards the quality of well water if left unattended or untreated. The study focuses on understanding the present condition of the wells and the water quality. It is imperative to have adequate monitoring and provide timely treatment to avoid future health risks due to the consumption of the well water. The well water quality testing of six well samples were collected during post-monsoon (October) season period. The key water quality parameters such as turbidity, temperature, pH, total dissolved solids (TDS), electrical conductivity and bacteriological contamination were examined with the H2S test used as an indicator of possible faecal pollution. The field observations and water temperature at the time of collection of samples helped relate laboratory findings to the local environmental settings. The results indicate that all the sampled wells were free from residual chlorine. Turbidity values for all samples are low (1.4-2.4 MTU) suggesting clear water with visible suspended matter, while TDS (20.3-113.3 mg/l) and electric conductivity (46.6-256 µS/cm) shows desirable limits, pointing to low mineralization and the absence of salinity related hazards. However, pH values reveal acidic conditions (5-6) in five wells with only one sample close to neutral (pH 7.01) due to solubility of certain metals. A critical finding of the study is that all six wells tested positive in the H2S bacteriological test showing the likely presence of faecal microbes and indicating water is unsafe to drink without prior treatment. The study recommends low-cost disinfection measures and greater community awareness. It also offers a baseline for further spatial analysis to support sustainable usage practices.

Keywords: Water Quality, Acidic Conditions, Sustainable Water Management.

Introduction:

In recent years, growing concern has been raised over deteriorating water quality due to the increased presence of pollutants such as heavy metals and pesticides, which pose serious risks to both human health and the environment. These contaminants are closely linked to the rise of non-communicable and infectious diseases. Regular and timely monitoring of water quality is therefore essential, as it plays a crucial role in safeguarding public health and preventing further degradation of natural habitats. The domestic wells remain as the crucial source of drinking in the rural areas of Goa and India. The study extends beyond water chemistry with spatial location, surrounding land use, settlement patterns and environmental settings that all together influences water quality. The physical and biological parameters provided importance to the suitability of groundwater for domestic use and help identify early signs of degradation.

Study Area:

The present study focuses on the Ponda Taluka, located in the central part of Goa, India. Ponda taluka is situated between approximately 15°18′ to 15°32′ North latitude and 73°55′ to 74°12′ East longitude. The main selected villages include Madapai, Tivrem, Tamsule, Mangueshi, Mardol and Marcaim village. Madapai and Tivrem are predominantly agrarian villages with scattered settlements and agricultural fields. Tamsule is a smaller village where groundwater sources play a crucial role in meeting daily water requirements. Mangueshi and Mardol are has higher population density and human activities, which may influence groundwater quality. Marcaim, located close to the industrial and transport corridor, experiences growing developmental pressures that can have an impact on local water resources.
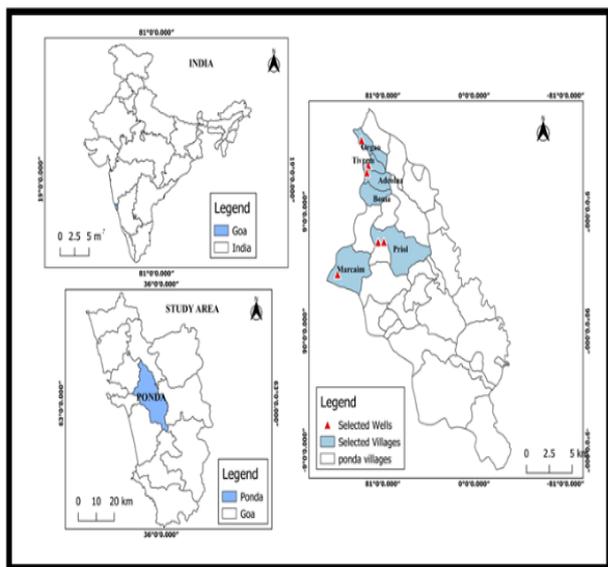

Figure 1: Study Area Map

Source: Prepared by Authors in QGIS 3.14 version, Survey of India, Toposheet (SOI)

Materials and Methods:

The study utilizes primary water quality data was obtained by testing was at a water treatment plant, ensuring standardized laboratory conditions. Although chemical parameters were not included, physical and biological parameters provided the basic quality, usability characteristics of groundwater. The data included Post Monsoonal seasonal observation that is from October, November and December at the wells of selected villages of Ponda taluka in Goa.
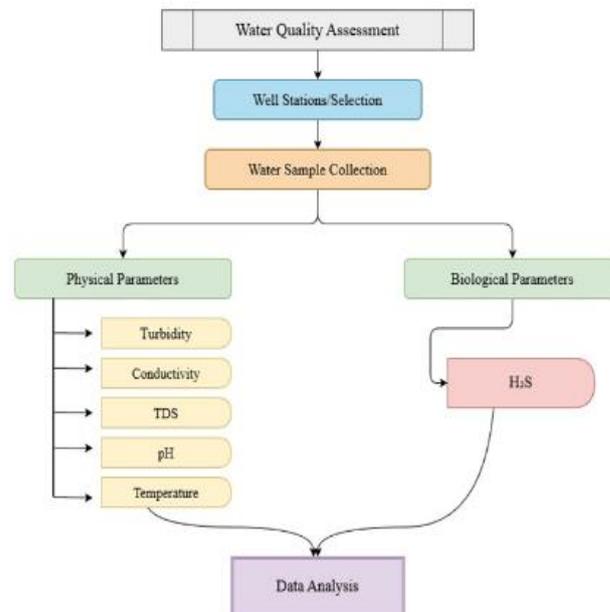

Figure 2: Methodology Chart

Source: Prepared by Authors, 2026

Physical Analysis:

The Physical parameters were analysed following standard protocols from the American Public Health Association (APHA, 2017) and BIS. The temperature of water samples was measured on-site at the time of collection and again in the laboratory during analysis. The thermometer probe was immersed directly into the water sample and the reading was recorded after stabilization. Physical water quality parameters such as temperature, turbidity, pH, electrical conductivity, TDS and residual chlorine were analysed using standard laboratory instruments and methods at a water treatment plant.

Temperature was enumerated by thermometric method, using calibrated thermometer by immersing the probe directly into the samples. Readings were recorded after attaining equilibrium. Temperature measurement

was carried out at the time of sample collection and laboratory analysis. Turbidity was measured using nephelometer. The method is based on the measurement of light scattered by suspended particles present in the water. The results were expressed in the Nephelometric Turbidity Units (NTU). pH was determined using a digital pH meter calibrated and the electrode was immersed in the sample and the pH values were recorded after stabilization. Electrical conductivity was measured using a conductivity meter. The method determines the ability of water to conduct electrical current, which depends on the concentration of dissolved ionic substances. Values were expressed in µS/cm. TDS was estimated using a digital TDS meter, which calculates dissolved solids based on conductivity values. The results were expressed in mg/L. Residual chlorine was determined using the DPD (N-N-diethyl-p-phenylenediamine) method. The appearance of pink colour indicated the presence of chlorine, while the absence of colour indicated no residual chlorine.

Microbiological Analysis:

Samples were collected in sterile bottles and analysed within 5 hours. Only one microbial indicator was enumerated due lack of facilities and machine misfunctioning in the laboratory. The Hydrogen Sulphide (H_2S) was enumerated using test kit. Special reagents were added in t all the six water samples. Development of colour and odour confirms the presence of hydrogen sulphide or sulphate reducing bacteria in groundwater.

Result and Discussion:

Data was statistically analysed using the features like trend lines and bar graph in MS excel.

Table: 1 Water Sample Testing Data

Well location	Temperature (°C)	Temperature (°C) (During collecting water sample)	Turbidity (NTU)	pH	TDS (mg/L)	Electrical Conductivity (µS/cm)	Chlorine	H_2S
Madapai	29.6	24.5	2.1	5.89	39	91.7	Absent	Positive
Tivrem	28.6	26.1	2.2	5.85	38.5	89.3	Absent	Positive
Tamsule	28.8	25.6	2.3	5.82	37.8	86.4	Absent	Positive
Mangueshi	29.7	27.2	2.2	5.78	36.2	84.1	Absent	Positive
Mardol	30.3	28.3	2.1	5.75	35	81.6	Absent	Positive
Marcaim	30.4	28.3	2.4	5.72	33.5	78.7	Absent	Positive

1. Temperature:

The graph shows the spatial variation of well water temperature measured at two different stages during sample collection in the field and during laboratory testing across the selected villages of Ponda Taluka. The temperature recorded during sample collection ranges approximately from 24.5°C to 28.3°C, while the temperature during laboratory testing varies between 28.6°C and 30.4°C. In all villages, the temperature measured during testing is consistently higher than that recorded at the time of sample collection. There is increase of temperature observed from Tivrem towards Mardol and Marcaim at both stages, suggesting the influence of local environmental factors such as well depth, land use and solar exposure. The differences between villages are marginal and fall within the normal temperature range for groundwater systems.
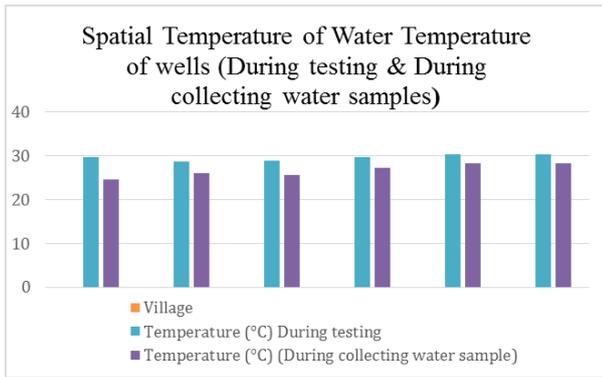
Figure 3: Spatial Temperature of water temperature of wells (During testing & during collecting water samples)

2. Turbidity:

The bar graph shows the village-wise variation of turbidity in well water across the selected villages of Ponda taluka. The turbidity values range from 2.1 NTU to 2.4 NTU which indicating very low and narrowly distributed turbidity levels among all the sampled wells. The lowest turbidity values (2.1 NTU) are observed in Madapai and Mardol, while the highest turbidity (2.4 NTU) is recorded in Marcaim. Villages such as Tivrem, Tamsule, and Mangueshi show marginally higher turbidity values ranging between 2.2 NTU and 2.3 NTU. These slight variations may be attributed to local geological conditions and minor surface runoff infiltration during groundwater recharge. Overall, all turbidity values are well within the permissible limit of 5 NTU as prescribed by BIS indicating good clarity of groundwater and minimal presence of suspended particles.
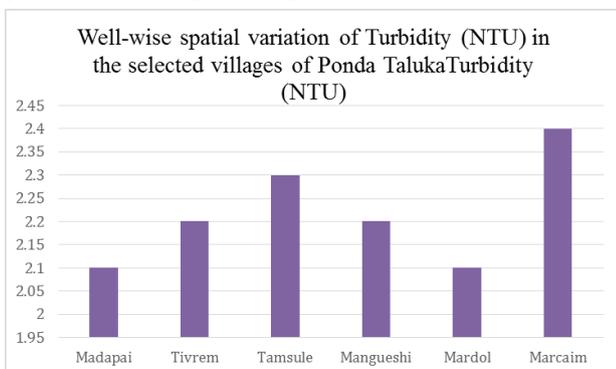

Figure 4: Well-wise spatial variation of Turbidity (NTU) in the selected villages of Ponda Taluka

3. Total Dissolved Solids (TDS):

The graph shows village-wise variation of Total Dissolved Solids (TDS) in well water across the selected villages of Ponda Taluka. TDS values range from 33.5 mg/L to 39.0 mg/L, with the highest value in Madapai and the lowest in Marcaim. A gradual decreasing trend is observed across the villages. All values are well within the BIS permissible limit of 500 mg/L, indicating fresh groundwater with low mineral content and overall good water quality. Therefore, all the values are below the acceptable limit of 500 mg/L prescribe by BIS. indicating that the groundwater is fresh, low in mineral content, and suitable for domestic use.
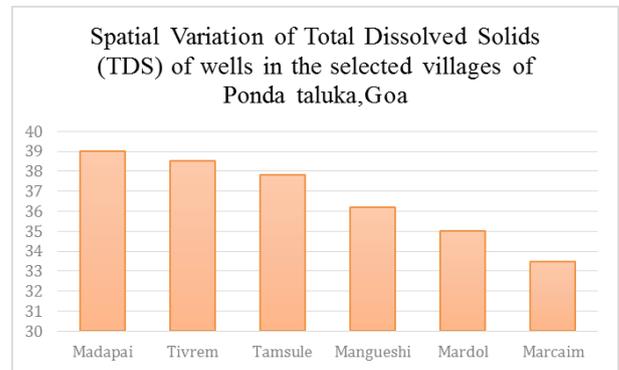

Figure 5: Spatial Variation of Total Dissolved Solids (TDS)

4. pH :

The graph shows the spatial trend of pH values in well water across the selected villages of Ponda Taluka. The pH values range from 5.72 to 5.89, indicating a slightly acidic nature of groundwater in all villages. The highest pH value is observed in Madapai, while the lowest is recorded in Marcaim, showing a gradual decreasing trend across the study area. All values fall below the BIS recommended range of 6.5-8.5, which may be attributed to lateritic soil conditions and organic matter influence. Overall, the pH variation is minor and reflects natural hydro-geochemical conditions rather than pollution.
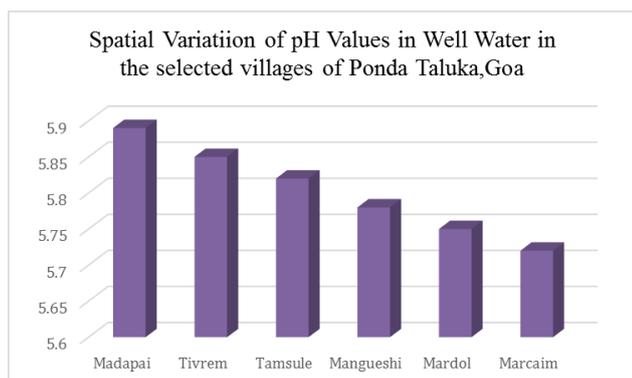
Figure 6: Spatial trend of pH in well water of Villages of Ponda Taluka

5. Electrical Conductivity :

The bar graph shows the village-wise variation of electrical conductivity in well water across the selected villages of Ponda Taluka. The conductivity values range from 78.7 µS/cm to 91.7 µS/cm, with the highest value observed in Madapai and the lowest in Marcaim. The low conductivity values across all villages suggest low dissolved salt content and confirm the fresh nature of groundwater in the study area. The observed decline in conductivity may be attributed to differences in local geology, soil characteristics and groundwater recharge conditions. Since no specific BIS limit is prescribed for conductivity, the values are interpreted in relation to TDS, which are also found to be low. Therefore, the graph indicates good groundwater quality with minimal mineralization across the selected villages.
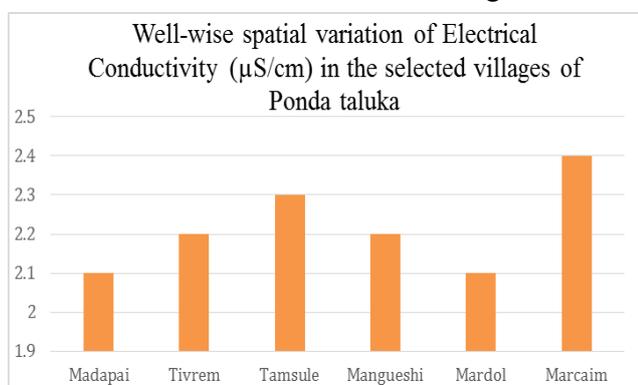

Figure 7: Village-wise variation of Electrical Conductivity of Villages of Ponda taluka

Major Findings:

❖ Water temperature shows only minor variation during testing and sample collection, indicating relatively stable groundwater conditions throughout the study area.

❖ Although Total Dissolved Solids (TDS) values differ from one village to another, they remain within permissible limits, reflecting low to moderate levels of mineral content in the groundwater.

❖ The pH values of well water across all villages are slightly acidic, which can be linked to factors such as soil characteristics, the presence of organic matter and interactions between groundwater and underlying rock formations.

❖ Electrical conductivity exhibits a gradual declining trend across the villages, pointing to variations in the concentration of dissolved ions in the well water.

❖ Residual chlorine was not detected in any of the water samples, confirming that the well water is largely untreated and does not undergo disinfection before use.

❖ In some wells, the presence of hydrogen sulphide (H_2S) indicates anaerobic conditions and is responsible for an unpleasant odour and quality and acceptability of the water.

Suggestions and Recommendations:

❖ Regular monitoring of well water quality is essential to identify seasonal variations and long-term changes in groundwater conditions. Continuous observation helps in early detection of any deterioration in water quality and supports timely management measures.

❖ Simple and cost-effective disinfection practices, such as chlorination or boiling, should be encouraged before using well water for drinking purposes to ensure microbial safety.

❖ Wells must be properly covered and maintained to protect them from surface runoff, household waste, and sewage intrusion.

❖ Local authorities should introduce a systematic well water surveillance programme in rural and semi-urban areas of Ponda Taluka to ensure regular assessment and safe use of groundwater resources.

❖ The installation of basic treatment measures, such as aeration units, can effectively reduce hydrogen sulphide concentration in wells affected by foul odour, thereby improving the quality of water.

Conclusion:

The present study on well water quality in the selected villages of Ponda Taluka reveals noticeable spatial variations in key physio-biological parameters, reflecting the influence of local hydro-geological and environmental conditions. Parameters such as Total Dissolved Solids (TDS), pH and electrical conductivity show a gradual declining trend across villages, indicating differences in mineral dissolution, aquifer characteristics and land-use practices. Although the observed values of pH and TDS remain within permissible limits, the slightly acidic nature of the water in all wells suggests the need for regular monitoring. The absence of residual chlorine in all samples indicates that the well water is untreated and lacks microbial protection, making it potentially vulnerable to contamination. Additionally, the presence of hydrogen sulphide (H_2S) in the samples affects the quality of water and points towards anaerobic conditions in the groundwater system.

References:

1. Survey of India. (2021). *Topographical Maps of Goa.* Government of India. https://surveyofindia.gov.in

2. Ezugwu, M. O., & Akhimien, F. O. (2022). Review of the effects of water characteristics and quality on human health. *International Journal of Current Science Research and Review*, 5(3), 673–685. https://doi.org/10.47191/ijcsrr/V5-i3-09Evaluation-of-Physical-Chemical-and-Biological-Characteristics-of.pdf

3. Murray, R. T., Rosenberg Goldstein, R. E., Maring, E. F., Pee, D. G., Aspinwall, K., Wilson, S. M., & Sapkota, A. R. (2018). Prevalence of microbiological and chemical contaminants in private drinking water wells in Maryland, USA. *International Journal of Environmental Research and Public Health, 15*(8), 1686. https://doi.org/10.3390/ijerph15081686ijerph_15_01686_pdf.pdf

4. Epule, E. T., Peng, C., Mirielle, M. W., & Mafany, N. M. (2011). Well water quality and public health implications: The case of four neighbourhoods of the city of Douala Cameroon. *Global Journal of Health Science, 3*(2), 75–89. https://doi.org/10.5539/gjhs.v3n2p75

5. Sani, M., Muazu, Z., & Dangaladima, H. (2023). An assessment of the physiochemical quality of drinking water from tube wells and its effects on human health in Sokoto metropolis. *Caliphate Journal of Science & Technology, 5*(2), 132–139. https://dx.doi.org/10.4314/cajost.v5i2.7

6. Latheef, L., Shibini Mol, P. A., Shadiya, M. A., Ramesh, R., & Afnitha, T. N. (2024). Well water quality analysis – Physical, chemical & microbiological parameters of water samples from Ernakulam District, Kerala, India. *Journal of Advanced Scientific Research, 15*(7), 16–21. https://doi.org/10.55218/JASR.2024150704