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Household Water Consumption, Access, and Affordability in Ledokombo Village: A Mixed-Method Descriptive Study

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ABSTRACT

Access to clean water remains a fundamental challenge in rural development, particularly in areas characterized by seasonal water fluctuations and fragmented supply systems. This study investigates household water consumption patterns, access structures, and affordability in Ledokombo Village, using a mixed-method descriptive approach. Data were collected from 10 purposively selected households through structured questionnaires, semi-structured interviews, and participant observation to provide both quantitative insights and qualitative depth. The findings reveal that while physical water access is stable, with 100% of respondents reporting 24-hour availability, the community faces a significant economic burden; more than half of the households allocate over 10% of their monthly expenditure to water-related costs. Furthermore, high daily consumption levels often exceeding 300 liters per household reflect demand driven by both domestic needs and broader livelihood activities. The study also identifies that residents actively utilize adaptive coping strategies and water conservation practices in response to resource limitations and financial pressures. The results highlight a structural imbalance between water accessibility and economic affordability, suggesting that rural water governance must transcend infrastructure expansion. It is recommended that policy interventions prioritize tariff optimization, the efficiency of community-based systems like PAMSIMAS, and the integration of water quality monitoring to ensure sustainable and equitable water management.

I. Introduction

Clean water access remains a critical component of rural development, particularly in regions where water availability fluctuates seasonally. Previous studies have highlighted disparities in rural water access across developing regions, emphasizing infrastructure limitations, governance challenges, and affordability constraints[1]. However, existing literature often focuses on macro-level indicators such as improved and unimproved water sources, without sufficiently addressing household-level dynamics of consumption behavior, cost burden, and adaptive strategies[2], [3]. In Indonesia, particularly in rural mountainous areas such as Ledokombo Village, empirical evidence remains limited regarding how households balance access, cost, and water usage behavior under fragmented water supply systems.

Ledokombo Village represents a complex rural water context where households depend on multiple sources, including PDAM/PAMSIMAS networks, private wells, and communal springs[4]. Despite nominal access to piped water systems, households frequently face economic pressure due to direct and indirect water costs, including purchasing water and maintaining alternative sources[5], [6]. This study is urgent because water access in rural areas is increasingly defined not only by availability but also by affordability and sustainability[7], [8]. Without localized empirical evidence, policy interventions risk focusing solely on infrastructure expansion without addressing actual household-level constraints.

Therefore, this study investigates household water consumption patterns, access structures, and affordability conditions in Ledokombo Village using a mixed-method descriptive approach.

II. Method

This study employs a mixed-methods descriptive approach to evaluate water needs and consumption patterns in Ledokombo Village. The design integrates quantitative descriptive analysis (structured questionnaires to map consumption volumes and expenditure) with qualitative inquiry (semi-structured interviews, participant observation, and document review) to capture community perceptions, adaptive behaviors, and management challenges[9]. This explicit mixed-methods framework ensures that both numerical patterns and contextual depth are addressed, resolving the earlier ambiguity between qualitative and mixed claims.

a. Research Design and Sampling

A purposive sampling strategy was employed to recruit ten households. The sample size was justified using the concept of information power which is well-suited to small scale exploratory investigations. Households were deliberately chosen to reflect a range of water use types namely, those dependent on PAMSIMAS, private wells, and communal sources. This method emphasizes depth of understanding over broad statistical generalization, allowing for a thorough examination of local water dynamics that a large-scale random survey might miss[10], [11]. Although the sample does not achieve statistical representativeness of the entire village, the variation in water-source dependency provides sufficient thematic saturation for the study's descriptive and exploratory objectives. Table 1 outlines the sampling criteria and their rationale.

Table 1. summarizes the sampling criteria and rationale

Criterion	Description	Justification
Water source type	PAMSIMAS, private well, communal source (each ≥3 households)	Captures variation in access, cost, and reliability
Household size	Small (1–3), medium (4–6), large (≥7)	Accounts for demand differences
Economic status	Low, middle, high (based on local asset index)	Ensures expenditure diversity
Geographic spread	Spatially distributed across the village	Avoids clustering effects

b. Data Collection

Three primary instruments were used, ensuring triangulation:

i. Structured questionnaires (quantitative)
Administered to 10 household heads. Collected data on daily water consumption (liters), source of water, cost per month, and basic demographic and economic information. Responses were tabulated and analyzed using descriptive statistics (percentages, means, range).

ii. Semi-structured interviews (qualitative)
Conducted with the same 10 households plus 5 key informants (village officials, PAMSIMAS operator, district water agency representative). Interview guides explored perceptions of water quality, reliability, management challenges, and adaptive behaviors. All interviews were audio-recorded (with consent) and transcribed verbatim.

iii. Participant observation and document review
The researcher visited each water source and observed usage patterns, maintenance practices, and community interactions. Local documents (village statistics, PAMSIMAS reports, prior project evaluations) were analyzed to contextualize infrastructure history and resource allocation.

c. Data Analysis

Data analysis comprised separate but integrated procedures:

i. Quantitative data from questionnaires were entered into spreadsheet software, cleaned, and analyzed using descriptive statistics. Consumption volumes and expenditures were expressed as percentages and compared across water-source types. Results are presented in tables and charts.

ii. Qualitative data from interviews, observation notes, and documents were analyzed using thematic analysis. The process involved:

a. Familiarization: reading transcripts multiple times.
b. Initial coding: open coding of key phrases and ideas.
c. Theme development: grouping codes into broader themes (e.g., "water scarcity coping behaviors", "infrastructure governance issues").
d. Review and refinement: cross-checking themes against raw data and field notes.
e. Integration: quantitative findings were juxtaposed with qualitative themes to identify patterns, contradictions, and holistic insights.

d. Research Area

Figure 1 displays the study site Ledokombo Village highlighted in red within Ledokombo Regency, East Java. The map shows the spatial distribution of PAMSIMAS infrastructure (orange strip) and major water sources. The village is characterized by a semi-arid climate with a pronounced dry season, making water access a critical issue.

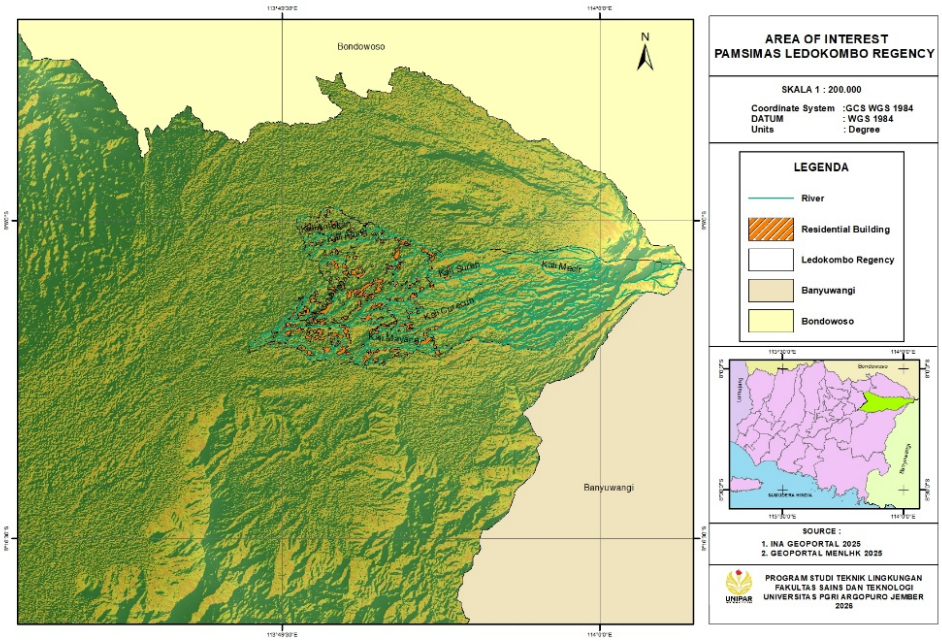

Fig 1. Administrative map of Ledokombo Village showing PAMSIMAS distribution points (orange strip), river (blue line)

To analyze household characteristics in Desa Ledokombo shown in Figure 1, this study utilized two primary inquiries directed at the participants. The first examined the current number of family members utilizing water within the household, while the second assessed fluctuations in family size over the preceding five-year period. The data gathered from the 10 respondents offer significant insights into household composition and demographic shifts, both of which are critical factors influencing water consumption behavior.

III. Results and Discussion

The results of this study indicate that household water conditions in Ledokombo Village reflect a combination of relatively stable access and complex usage patterns. Most households consist of medium-sized families with 4–5 members, and the majority reported no significant changes in household size over the past five years. However, a smaller proportion of households experienced either an increase or decrease in family members, indicating gradual demographic shifts that may influence future water demand. These findings suggest that household structure in the village remains relatively stable, yet still dynamic enough to require adaptive water planning strategies. This is shown in figure 2 Results of part A questionnaire.

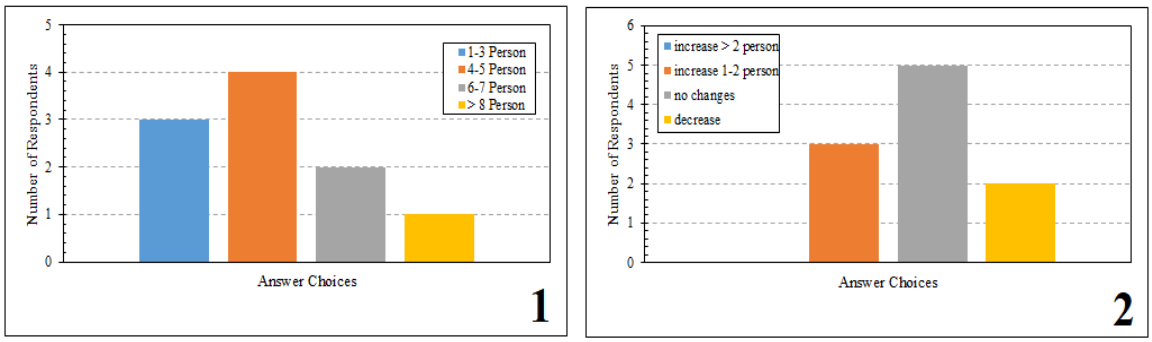

Fig 2. Results of part A questionnaire

In terms of water access and consumption behavior, households rely on a mix of water sources, including PDAM/PAMSIMAS networks, private wells, communal springs, and purchased water. Despite this diversity, all respondents reported continuous 24-hour water availability, indicating that physical access is generally adequate. However, consumption levels vary significantly, with half of the households reporting daily use exceeding 300 liters. This high consumption pattern reflects not only domestic needs but also broader livelihood activities, suggesting that water demand in the village extends beyond basic household usage. At the same time, more than half of respondents allocate over 10% of their monthly expenditure to water-related costs, highlighting a clear affordability burden despite stable access conditions. This is illustrated in Figure 3 Results of part B questionnaire.

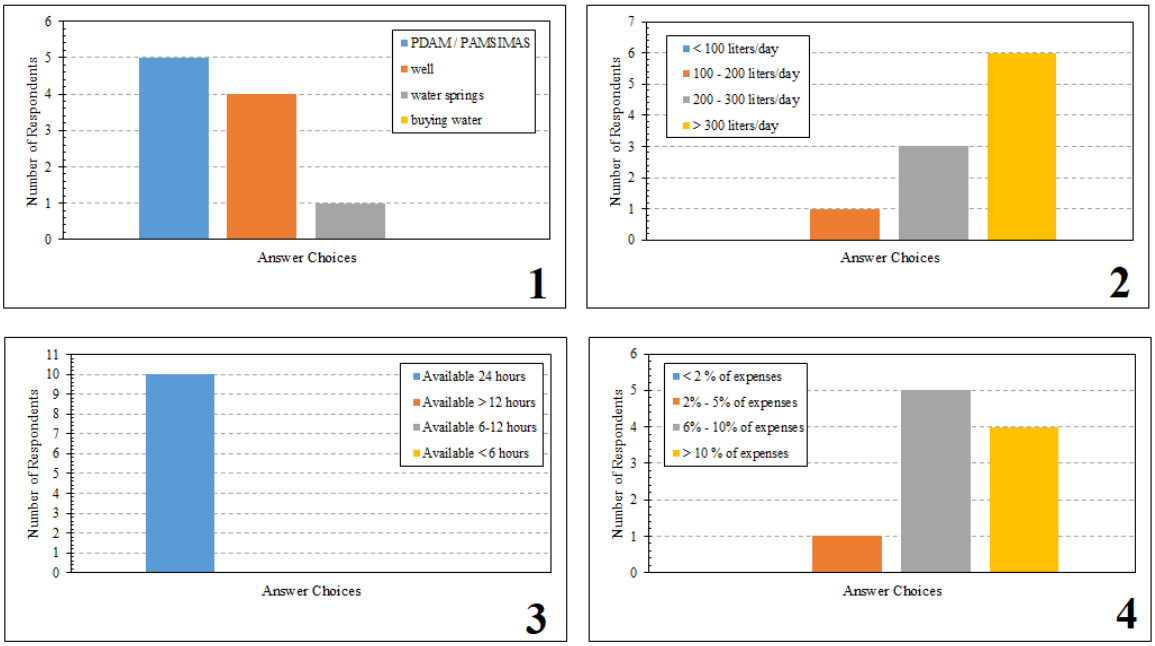

Fig 3. Results of part B questionnaire

This is presented in Figure 4, results of part C questionnaire further reveals that perceived water quality and household coping behavior play an important role in shaping water use practices. While

most respondents reported moderate satisfaction with water quality, concerns remain regarding clarity, taste, and odor, particularly among households relying on non-piped sources. These perceptions are consistent with the presence of fragmented water supply systems, where quality differences exist across sources. Interestingly, the majority of respondents demonstrate strong water conservation behavior, indicating high awareness of resource limitations and cost pressures. This adaptive behavior suggests that households actively respond to water-related challenges through demand-side adjustments rather than increasing reliance on external supply solutions.

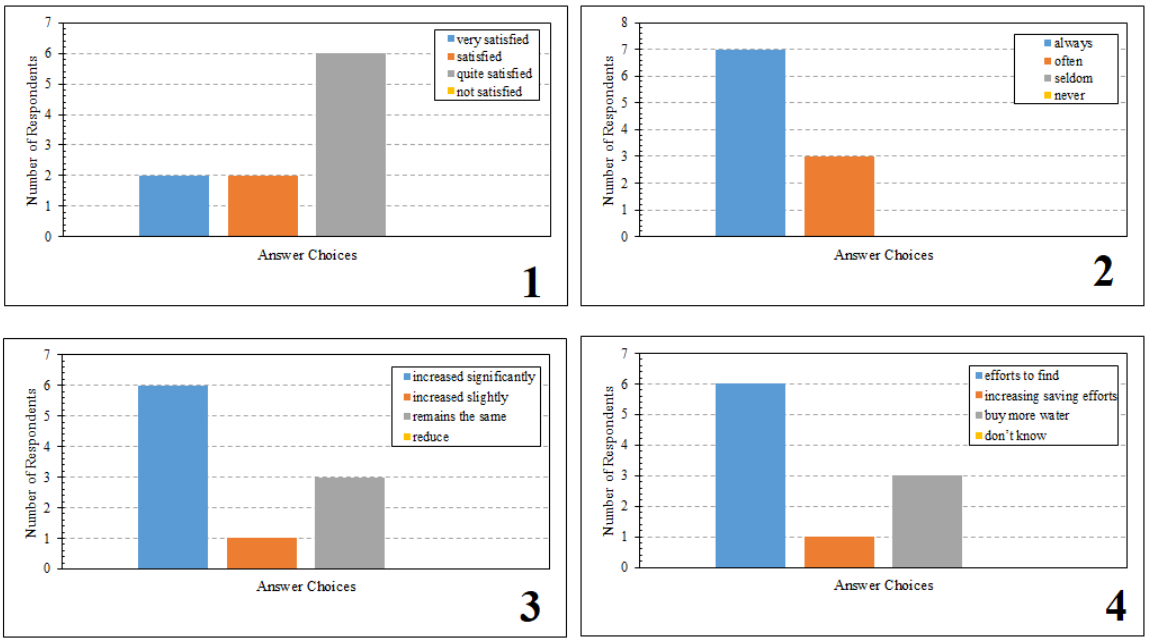

Fig 4. Results of part C questionnaire

Future water demand projections further reinforce the urgency of improving local water management systems. Most households anticipate an increase in water needs over the next five years, primarily driven by household growth and changing consumption patterns. In response to potential demand pressures, the majority of respondents prefer strengthening conservation practices rather than seeking additional water sources or increasing water purchases. This behavioral orientation highlights a strong community tendency toward sustainability-oriented coping strategies. Overall, the findings demonstrate a structural imbalance between water accessibility, affordability, and quality, emphasizing the need for integrated policy interventions that focus on tariff optimization, infrastructure equity, and strengthening community-based water management systems.

IV. Conclusion

This study highlights a structural gap between physical water availability and economic affordability in rural water systems. While households in Ledokombo Village benefit from continuous water access, they experience significant financial pressure due to water-related costs. The study contributes to rural water governance literature by demonstrating that water access should be evaluated not only in terms of infrastructure availability but also affordability and household coping behavior. Policy interventions should focus on tariff optimization, strengthening efficiency of PAMSIMAS systems, and promoting community-based water conservation strategies. Strengthening water quality monitoring is also essential to improve user satisfaction and public health outcomes.

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