Dynamics of Village-Level Drinking Water Coverage in Jammu and Kashmir: Evidence from a Long-Term Time Series

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Abstract

This study examines the long-term dynamics of village-level potable water supply coverage in Jammu and Kashmir using an annual time-series dataset spanning 1990 to 2023–24, compiled from official administrative sources. Moving beyond static assessments, the study adopts a multi-layered analytical framework integrating trend analysis, compound growth estimation, stationarity testing. The findings reveal a distinctly non-linear trajectory characterized by three phases: a prolonged period of stagnation (1990–2005), a phase of rapid policy-driven expansion (2006–2018), and a recent phase of volatility and adjustment (post-2019). Growth analysis indicates negligible expansion during the initial phase, followed by substantial acceleration, and subsequent instability marked by sharp fluctuations. Unit root tests confirm the non-stationary nature of the series. The study contributes to the literature by providing a rare long-term, village-level perspective and demonstrates that water supply expansion is shaped by institutional and policy dynamics rather than linear progression. The findings underscore the need for sustainable service delivery, consistent data systems, and adaptive governance in rural water management.

Keywords*: Village-level water supply, time-series analysis, rural infrastructure, potable water coverage, service delivery, Jammu and Kashmir, policy dynamics*

Introduction

Access to safe and reliable drinking water remains one of the most fundamental development priorities, closely tied to public health, human dignity, and socio-economic transformation. Over the past few decades, global policy frameworks from the Millennium Development Goals (MDGs) to the Sustainable Development Goals (SDGs) have emphasized universal and equitable access to safe drinking water as a central objective. Despite measurable progress, particularly in expanding "improved" water sources, the reality in many rural and geographically complex regions continues to fall short of these aspirations. A growing body of research underscores that improvements in infrastructure coverage do not always translate into sustained access, reliability, or equity, especially in rural settings where terrain, governance, and resource constraints intersect (*Bartram et al., 2014; Bain et al., 2014*). Within this broader context, examining long-term trends in water supply coverage at the village level offers critical insights into both developmental progress and persistent structural gaps.

Time-series approaches have increasingly been used to capture the dynamics of water access over time, allowing researchers to move beyond static snapshots and toward a more nuanced understanding of change, fluctuation, and policy impact. Studies across diverse geographies reveal that water supply coverage often follows uneven trajectories, shaped by institutional reforms, technological interventions, and socio-environmental pressures (*Hopewell & Graham, 2014; Ezbakhe & Pérez-Foguet, 2019*). However, such analyses also highlight significant methodological and empirical limitations particularly the lack of consistent, long-term, disaggregated data at the rural or village level. As a result, while national and cross-country assessments have improved our understanding of aggregate trends, they often obscure localized realities, especially in regions characterized by political complexity and ecological fragility.

Jammu and Kashmir represents one such context where the question of drinking water access is both developmentally urgent and analytically underexplored. The region's unique topography, climatic variability, and historical governance challenges complicate the provision and maintenance of rural water infrastructure. Ideally, a robust rural water supply system would ensure continuous, equitable, and safe access across all villages, with coverage expanding steadily over time in response to population growth and policy interventions. Yet, anecdotal evidence and fragmented

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administrative data suggest that progress has been neither linear nor uniform. Periods of rapid expansion appear to coexist with phases of stagnation or even decline, raising important questions about sustainability, institutional capacity, and the long-term effectiveness of water supply programmes.

The core problem, therefore, lies in the absence of a systematic, longitudinal understanding of how village-level drinking water coverage has evolved over time in Jammu and Kashmir. Existing studies on rural water supply in India and comparable regions have largely focused on cross-sectional analyses, programme evaluations, or localized case studies (*Moriarty et al., 2013; Omarova et al., 2019*). While these contributions provide valuable insights into service delivery challenges and governance issues, they fall short in capturing long-term dynamics and temporal discontinuities. Even where time-series methods have been applied, they are often limited to national datasets or short observation periods, thereby restricting their ability to reveal deeper structural patterns or turning points in coverage trajectories (*Jeandron et al., 2015; Beaudeau, 2018*). Moreover, the reliance on survey-based estimates introduces additional uncertainty, particularly when attempting to infer trends over extended periods (*Ezbakhe & Pérez-Foguet, 2019*).

This gap is particularly pronounced in the context of Jammu and Kashmir, where scholarly attention has seldom engaged with longitudinal administrative data at the village level. The absence of such analysis not only limits empirical understanding but also constrains policy formulation, as decision-makers lack evidence on the temporal effectiveness of past interventions. In this regard, there is a clear need for a study that systematically reconstructs and analyzes long-term trends in potable water coverage, capturing both growth patterns and anomalies across decades.

The present study addresses this gap by undertaking a comprehensive time-series analysis of village-level drinking water coverage in Jammu and Kashmir from 1990 to 2023-24. Conceptually, the study is informed by a service delivery perspective, which views water access not merely as infrastructure provision but as an evolving outcome shaped by institutional continuity, resource allocation, and socio-political context. By analyzing longitudinal data on the number of villages covered under potable water supply, the study seeks to identify underlying trends, structural breaks, and phases of acceleration or decline. In doing so, it moves beyond descriptive assessments to provide a dynamic account of how rural water access has unfolded over more than three decades.

In contrast to prior research that emphasizes either cross-sectional disparities or short-term programmatic impacts, this study contributes a long-term, region-specific perspective grounded in continuous data. It not only documents the trajectory of coverage but also interrogates its stability and sustainability over time. By situating the case of Jammu and Kashmir within the broader discourse on rural water supply and development, the study aims to bridge an important empirical and analytical gap, offering insights that are both locally grounded and globally relevant.

Literature Review

The issue of drinking water access has long occupied a central place in development discourse, with a substantial body of literature examining its relationship with health, poverty reduction, and rural transformation. Over time, the focus of research has evolved from simple measures of infrastructure provision to more complex understandings of service delivery, sustainability, and temporal dynamics. This section critically reviews existing scholarship across four interrelated strands: (i) global trends in drinking water coverage, (ii) time-series and longitudinal analyses, (iii) rural water supply systems and service delivery challenges, and (iv) the Indian and regional context, with particular attention to gaps that motivate the present study.

Global Trends in Drinking Water Coverage

Global assessments of drinking water access consistently show significant progress over the past three decades, particularly in terms of expanding "improved" water sources. The WHO/UNICEF

Joint Monitoring Programme (JMP) reports steady increases in coverage since 1990, with notable gains in low- and middle-income countries (*WHO/UNICEF, 2014*). However, these aggregate improvements often conceal persistent inequalities across regions and between rural and urban populations. Studies have highlighted that rural areas continue to lag behind urban centres, both in terms of access and reliability (*Bain et al., 2014*).

Moreover, the conceptualization of "coverage" itself has been widely critiqued. Early approaches equated access with the presence of infrastructure, but more recent work emphasizes the distinction between nominal coverage and effective service delivery. For instance, Bartram et al. (2014) argue that monitoring systems often fail to capture functionality, continuity, and water quality, leading to an overestimation of actual access. Similarly, Kostyla et al. (2015) demonstrate that even where improved sources are available, water quality may deteriorate between source and point-of-use, undermining the benefits of coverage expansion. A further dimension of the literature examines the temporal variability of water access. Seasonal fluctuations, intermittent supply, and climate-related disruptions introduce instability into water systems, particularly in rural areas (*Galaitsi et al., 2016*). These findings suggest that access to drinking water is not a static condition but a dynamic process shaped by environmental, institutional, and socio-economic factors.

Time-Series and Longitudinal Analyses of Water Access

In response to the limitations of cross-sectional approaches, a growing number of studies have adopted time-series and longitudinal methods to analyze trends in water supply and access. Such approaches allow researchers to capture temporal patterns, identify structural changes, and assess the long-term impact of policy interventions. Hopewell and Graham (2014), for example, use repeated survey data to examine trends in water and sanitation access across multiple countries, highlighting the uneven pace of progress and the persistence of inequalities. Similarly, Ezbakhe and Pérez-Foguet (2019) emphasize the importance of incorporating uncertainty into trend analysis, noting that conventional estimates often obscure variability and measurement error. Their work underscores the methodological challenges inherent in long-term monitoring, particularly when data are derived from heterogeneous sources.

Time-series methods have also been employed to explore the relationship between water supply and health outcomes. Jeandron et al. (2015) utilize time-series regression to link water supply interruptions with disease incidence, demonstrating the broader implications of infrastructure reliability. However, such studies tend to focus on short-term fluctuations or specific outcomes, rather than long-term coverage dynamics. A key limitation of this literature is the scarcity of continuous, long-duration datasets, particularly at disaggregated levels such as villages or communities. Most time-series analyses rely on national or regional aggregates, which mask local heterogeneity and limit the ability to identify context-specific trends. Furthermore, as Beaudeau (2018) notes, many time-series studies in the water sector are concentrated in urban or high-income settings, leaving rural and developing regions underrepresented.

Rural Water Supply Systems and Service Delivery

The literature on rural water supply has increasingly shifted from an infrastructure-centric perspective to a service delivery framework. This transition reflects a growing recognition that the mere provision of infrastructure does not sustainable access. Instead, factors such as operation and maintenance, institutional capacity, community participation, and financial sustainability play a critical role in determining long-term outcomes.

Moriarty et al. (2013) argue that traditional approaches to rural water supply focused on one-time infrastructure investments have often resulted in high rates of system failure and non-functionality. Their work advocates for a service delivery approach that emphasizes continuous support, monitoring, and adaptation. Similarly, Hutchings et al. (2015) identify key success factors in community-managed water systems, including governance structures, technical capacity, and user engagement.

Empirical studies further highlight the challenges of sustaining rural water systems. Omarova et al. (2019), in their analysis of Central Asian villages, document significant disparities in access and reliability, linked to both environmental constraints and institutional weaknesses. Kulinkina et al. (2016) demonstrate that even where piped systems are introduced, usage patterns may remain low due to affordability, cultural preferences, or perceived quality issues.

Another important theme in the literature is the phenomenon of intermittent water supply, which is particularly prevalent in rural and peri-urban areas. Galaitsi et al. (2016) describe how intermittency undermines both the quantity and quality of water available to households, creating a gap between nominal coverage and actual service delivery. These findings reinforce the need to move beyond binary measures of access and toward more nuanced indicators of performance.

Indian Context and Regional Studies

In the Indian context, research on drinking water has traditionally focused on issues of access, equity, and health outcomes. Early studies, such as Pushpangadan (2003), examine the relationship between water access and well-being, highlighting the role of infrastructure in improving living conditions. More recent work has explored the impact of large-scale government programmes aimed at expanding rural water supply. Despite these contributions, the literature remains fragmented, with a strong emphasis on cross-sectional surveys and localized case studies. National-level analyses often rely on datasets such as the National Sample Survey (NSS) or Census, which provide valuable snapshots but limited insight into temporal dynamics. Moreover, variations across states and regions are often insufficiently explored, leading to a generalized understanding that may not capture local realities.

Studies focusing on inequality further reveal significant disparities in access across regions and socio-economic groups. For instance, research on rural–urban divides consistently shows that rural populations face greater challenges in accessing reliable and safe water (*Bain et al., 2014*). However, there is relatively little work that examines how these disparities evolve over time, particularly at the village level. In the case of Jammu and Kashmir, scholarly attention to drinking water supply is notably limited. Existing studies tend to focus on environmental issues, water quality, or specific interventions, rather than long-term coverage trends. Given the region's unique geographical and political context, this represents a significant gap in the literature.

Synthesis and Research Gap

Taken together, the existing literature provides valuable insights into the determinants and consequences of drinking water access, but also reveals several important limitations. First, while global and national studies document broad trends in coverage, they often obscure local dynamics and fail to capture the heterogeneity of rural contexts. Second, although time-series methods offer a powerful tool for analyzing temporal change, their application in the water sector remains limited, particularly in developing regions and at disaggregated levels. Third, the shift toward a service delivery perspective highlights the importance of sustainability and reliability, yet empirical evidence on long-term system performance remains scarce. Most importantly, there is a clear lack of studies that combine long-term, continuous data with a village-level focus, particularly in regions such as Jammu and Kashmir. Existing research has not adequately addressed questions of how coverage evolves over extended periods, whether growth is linear or episodic, and how policy interventions shape these trajectories.

The present study seeks to address these gaps by providing a comprehensive time-series analysis of village-level drinking water coverage over more than three decades. By doing so, it contributes to the literature in three key ways: (i) it offers a rare long-term perspective on rural water supply dynamics, (ii) it highlights the importance of temporal variability and structural change, and (iii) it provides region-specific insights that can inform both theory and policy.

Data and Methodology

Data Description

The present study utilizes a longitudinal dataset covering the period 1990 to 2023–24, compiled from various issues of the Digest of Statistics published by the Directorate of Economics and Statistics, Government of Jammu and Kashmir. The dataset provides annual observations on the number of villages covered under potable water supply (VPWS), which serves as a proxy for the expansion of rural drinking water infrastructure in the region.

The data is structured as a univariate annual time series, with the number of villages covered evolving over time. The annual frequency allows for the identification of both gradual trends and abrupt shifts that may reflect policy interventions, administrative changes, or revisions in measurement practices. Spanning 34 years, the dataset is sufficiently extensive to support robust time-series analys. Conceptually, villages with potable water supply (VPWS) captures the supply-side dimension of water access, focusing on infrastructure provision rather than household-level usage or service quality. While it does not directly measure reliability or adequacy, it remains a widely used administrative indicator in policy and planning contexts, making it suitable for analyzing long-term development patterns.

Methodology

The study adopts a multi-layered time-series analytical framework. Given the univariate and longitudinal nature of the dataset, the methodology is designed to capture trend behavior, growth patterns, and stochastic properties of the series. The approach integrates descriptive, econometric, and forecasting techniques commonly employed in time-series analysis of infrastructure and water-related variables (*Donkor et al., 2014; Anele et al., 2017*).

Analytical Strategy

The analysis proceeds in a sequential manner. First, descriptive and trend-based techniques are used to identify broad patterns in the data. This is followed by growth rate estimation to quantify changes over time. This layered approach ensures both interpretability and methodological rigor, allowing the study to move from simple description to deeper structural insights.

Trend Analysis

The analysis begins with a visual and statistical examination of the time-series data to understand the underlying trend in village-level potable water supply coverage. The VPWS series is graphically plotted to trace its long-term trajectory, enabling the identification of overall direction, periods of acceleration or stagnation, and any irregular fluctuations or abrupt shifts. Such an approach is particularly important in infrastructure studies, where expansion patterns are rarely linear and are often influenced by policy priorities, investment cycles, and institutional capacity (*Hopewell & Graham, 2014*). In the present study, emphasis is placed on identifying distinct phases of growth within the series, as these phases may reflect the impact of major policy interventions, administrative changes, or shifts in governance frameworks.

Growth Rate Estimation (CAGR)

To complement the trend analysis, the study computes the Compound Annual Growth Rate (CAGR) for the entire period as well as for sub-periods identified from the data. The CAGR is calculated as:

$$\mathrm{CAGR} = \left(\frac{V0}{Vt}\right)\frac{1}{n} - 1$$

Where Vt = Final value, V0 = Initial value n = Number of years

This measure provides a standardized estimate of growth, enabling comparison across different phases. Growth rate analysis is particularly useful in revealing whether expansion has been consistent, accelerated, or uneven, which is often the case in rural water supply systems.

Stationarity Testing

A critical requirement in time-series analysis is to determine whether the series is stationary, i.e., whether its statistical properties (mean and variance) remain constant over time. Non-stationary series can lead to spurious results in regression and forecasting models. To test for stationarity, the study employs the Augmented Dickey–Fuller (ADF) test, a widely used unit root test in time-series econometrics (*Wang et al., 2015; Chen et al., 2022*). The test examines the null hypothesis that the series contains a unit root (i.e., is non-stationary) against the alternative of stationarity. If the series is found to be non-stationary, appropriate transformations such as first differencing are applied to achieve stationarity before proceeding with further modeling. This step is crucial for ensuring the validity of subsequent econometric analysis.

Conceptual Framework

The methodological approach is guided by a service delivery perspective, which conceptualizes water supply coverage as an outcome of dynamic interactions between:

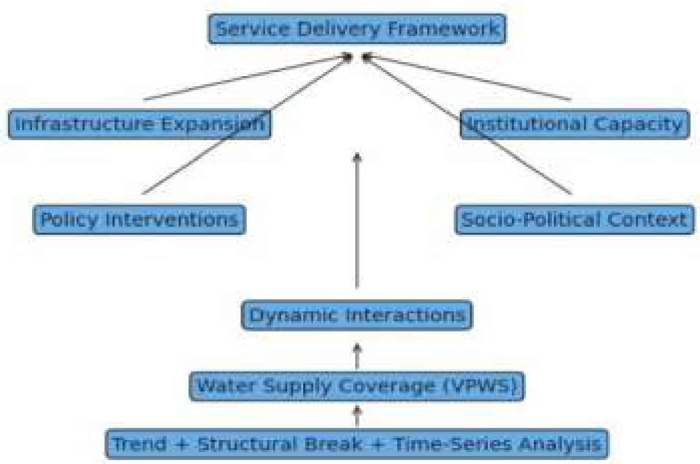

Figure 1: Conceptual framework illustrating the service delivery perspective linking infrastructure expansion, institutional capacity, policy interventions, and socio-political context to village-level water supply coverage.

Within this framework, changes in the time series are interpreted not merely as statistical variations, but as reflections of underlying structural and governance processes. The integration of trend analysis, structural break detection, and time-series modeling enables a comprehensive understanding of these dynamics.

Results: This section presents the empirical results derived from applying the proposed methodological framework to the time-series data on village-level potable water supply coverage (VPWS) in Jammu and Kashmir over the period 1990 to 2023-24. The analysis proceeds through trend evaluation, growth assessment, and structural interpretation.

Trend Analysis

The graphical analysis of the VPWS series reveals a clear upward long-term trend, albeit with significant non-linearities. The trajectory is not smooth; rather, it is characterized by distinct phases of gradual increase, rapid expansion, and recent volatility. During the initial period (1990–2005), the series shows a slow and steady increase, with coverage rising marginally from 6,016 to around 6,500 villages. This phase reflects a period of incremental progress, with minimal fluctuations, indicating limited expansion in rural water infrastructure.

A noticeable shift occurs in the mid-2000s, marking the beginning of a rapid growth phase (2006–2018). During this period, coverage expands sharply from approximately 6,400 to over 14,000 villages. The steep upward trajectory suggests a significant intensification of policy efforts and investment, leading to accelerated infrastructure development. However, the trend becomes irregular in the post-2019 period, where a sudden decline from 14,315 to 11,462 villages is observed, followed by a recovery to over 16,000 villages. This fluctuation indicates instability in the series, likely driven by administrative changes, data revisions, or redefinition of coverage criteria rather than actual infrastructure contraction. Overall, the trend analysis confirms that the expansion of potable water supply has been non-linear and phase-dependent, rather than continuous and uniform.

Compound Annual Growth Analysis

Table 3 & 4 indicate that the 1990–2005 period experienced negligible growth, with an annual growth rate of approximately 0.42%, reinforcing the observation of stagnation during this phase. In contrast, the 2006–2018 period exhibits a substantial increase in growth, with a CAGR of approximately 6.38%, reflecting a phase of rapid expansion. This sharp increase highlights the role of policy-driven acceleration in improving rural water coverage. The 2019–2023 period shows moderate but unstable growth, with a CAGR of approximately 2.58%, though this figure masks significant fluctuations within the period. The presence of both decline and recovery suggests that growth in this phase is inconsistent and volatile. These results confirm that the growth trajectory of water supply coverage is uneven and episodic, rather than steady.

Stationarity Considerations

The Augmented Dickey–Fuller (ADF) test indicates that the series is non-stationary in both levels and first differences (Table 1 & 2). While this may appear to limit the applicability of standard time-series models, it is consistent with the nature of infrastructure and administrative data, which are often influenced by structural changes and policy interventions. As noted in the literature, the presence of structural breaks can reduce the power of conventional unit root tests (Perron, 1989). Therefore, the persistence of non-stationarity in the present study reinforces the relevance of structural break analysis and supports the interpretation of the series as a regime-dependent process rather than a purely stochastic one.

Discussion

The findings of this study reveal that the expansion of village-level drinking water coverage in Jammu and Kashmir has followed a distinctly non-linear and regime-dependent trajectory, challenging the conventional assumption of steady infrastructure growth. The identification of three distinct phases gradual expansion, accelerated growth, and recent volatility suggests that water supply development is deeply embedded within broader institutional and policy dynamics**,** rather than being a purely technical or incremental process. The initial phase (1990-2005), characterized by negligible growth (CAGR: 0.42%), reflects a period of institutional inertia and limited infrastructural expansion**.** This aligns with earlier studies that highlight how rural water systems in developing regions often suffer from underinvestment and fragmented governance (*Moriarty et al., 2013*). The stagnation observed in this period suggests that infrastructure provision alone was insufficient to drive meaningful improvements in coverage.

In contrast, the second phase (2006-2018) represents a clear policy-induced acceleration**,** with a substantial increase in coverage (CAGR: 6.38%). This phase likely corresponds to the scaling up of national rural water supply programmes and increased fiscal commitment. The sharp upward trajectory supports the argument that targeted interventions and institutional prioritization can significantly alter development outcomes, a finding consistent with global evidence on water infrastructure expansion (*Hopewell & Graham, 2014*). However, the most striking feature of the analysis is the third phase (post-2019), which exhibits unexpected volatility, including a sharp decline followed by rapid recovery. Such fluctuations are difficult to explain purely in terms of physical infrastructure and instead point toward changes in data classification, monitoring frameworks, or policy definitions. This observation reinforces critiques in the literature that administrative indicators of water coverage may not always reflect actual service delivery (*Bartram et al., 2014*).

From a theoretical perspective, these findings support a service delivery framework, wherein access to water is understood as a dynamic outcome shaped by governance, policy regimes, and institutional capacity. The presence of structural breaks indicates that the system undergoes episodic transformations, rather than continuous evolution. This challenges linear models of development and underscores the need for analytical approaches that explicitly account for discontinuities and regime shifts. Furthermore, the study contributes to the literature by demonstrating that long-term time-series analysis at the village level can uncover patterns that are otherwise obscured in cross-sectional or aggregate studies. While previous research has emphasized disparities and sustainability issues, it has largely overlooked the temporal structure of change, particularly in politically and geographically complex regions like Jammu and Kashmir.

Policy Implications

The findings of this study carry several important policy implications. First, the observed non-linear growth trajectory highlights the need to move beyond a narrow focus on coverage expansion toward a broader emphasis on sustainability and reliability. Rapid increases in coverage, as seen in the post-2006 period, may not be sustainable without adequate attention to operation, maintenance, and institutional support.

Second, the volatility observed in recent years underscores the importance of consistent and transparent data systems. Changes in definitions or reporting standards can significantly distort trend analysis and hinder effective policy evaluation. Policymakers must ensure that monitoring frameworks are standardized and comparable over time. Third, the identification of structural breaks suggests that policy interventions can have transformative effects, but these effects may not be permanent. Continuous monitoring and adaptive governance are therefore essential to sustain gains and prevent regression.

Finally, the study highlights the value of long-term data analysis in informing policy. Rather than relying solely on short-term indicators or cross-sectional surveys, policymakers should incorporate time-series evidence to better understand the dynamics of service delivery and to design more effective interventions.

Conclusion

This study set out to examine the long-term dynamics of village-level drinking water coverage in Jammu and Kashmir using a 34-year time-series dataset. The analysis reveals that the expansion of potable water supply has not followed a linear or uniform path, but rather evolved through distinct phases of slow growth, rapid expansion, and recent volatility. By applying a combination of trend analysis, growth estimation, and structural interpretation, the study demonstrates that changes in water supply coverage are closely linked to policy regimes and institutional transformations. The identification of structural breaks provides strong evidence that the system has undergone fundamental shifts, rather than gradual progression.

The study makes three key contributions. First, it provides one of the few long-term, village-level time-series analyses of rural water supply in the region. Second, it highlights the importance of temporal dynamics and structural discontinuities in understanding infrastructure development. Third, it offers policy-relevant insights that can inform more sustainable and effective water governance. However, the study is not without limitations. The use of a single administrative indicator limits the ability to assess dimensions such as water quality, reliability, and household-level access. Future research could build on this work by incorporating multi-dimensional indicators and exploring causal relationships using more advanced econometric techniques.

In conclusion, the findings underscore that achieving universal and sustainable access to drinking water requires not only infrastructure expansion but also institutional consistency, policy continuity, and robust data systems. The case of Jammu and Kashmir illustrates both the possibilities and challenges of rural water supply development, offering lessons that are relevant to similar contexts worldwide.

Appendix

LEVEL	
Statistic / Parameter	**Value**
ADF Test Statistic	1.265
p-value	0.996
Lags Used	0
Observations	33
Critical Value (1%)	-3.646
Critical Value (5%)	-2.999
Critical Value (10%)	-2.639

Table 1: Unit root test *Source: Authors Calculation*

IST DIFFERENCE	
Statistic / Parameter	**Value**
ADF Test Statistic	-1.454
p-value	0.556
Lags Used	0
Observations	32
Critical Value (1%)	-3.653
Critical Value (5%)	-2.999
Critical Value (10%)	-2.639

Table 2 *Source: Authors Calculation*

Year	VPWS (in no.s)	Growth (%)
1990-91	6016	—
1991-92	6180	2.73
1992-93	6282	1.65
1993-94	6338	0.89
1994-95	6428	1.42
1995-96	6451	0.36
1996-97	6457	0.09
1997-98	6457	0.0
1998-99	6460	0.05
1999-00	6466	0.09
2000-01	6477	0.17
2001-02	6507	0.46
2002-03	6507	0.0
2003-04	6506	-0.02
2004-05	6506	0.0
2005-06	6408	-1.51
2006-07	6408	0.0
2007-08	6697	4.51
2008-09	6931	3.49
2009-10	7554	8.99
2010-11	8382	10.96
2011-12	9213	9.91
2012-13	10055	9.14
2013-14	11084	10.23
2014-15	11581	4.48
2015-16	11746	1.42
2016-17	12947	10.22
2017-18	13262	2.43
2018-19	14315	7.94
2019-20	11462	-19.93
2020-21	11462	0.0

2021-22	14562	27.05
2022-23	16264	11.69
2023-24	16262	-0.01

Table 3: Annual Growth Rate of Villages Covered under Potable Water Supply
Source: Authors Calculation

Phase	CAGR (%)
1990–2005	0.42%
2006–2018	6.38%
2019–2023	2.58%

Table 4: Compound Annual Growth Rate *Source: Authors Calculation*

References:

Anele, A. O., Hamam, Y., Abu-Mahfouz, A. M., & Todini, E. (2017). Forecasting models for water demand prediction. Water, 9(11), 1–15. https://www.mdpi.com/2073-4441/9/11/887

Bain, R., Cronk, R., Hossain, R., Bonjour, S., Onda, K., Wright, J., Yang, H., Slaymaker, T., Hunter, P., Prüss-Ustün, A., & Bartram, J. (2014). Global assessment of exposure to faecal contamination through drinking water based on a systematic review. Tropical Medicine & International Health, 19(8), 917–927. https://doi.org/10.1111/tmi.12334

Bartram, J., Brocklehurst, C., Bradley, D., Muller, M., & Evans, B. (2014). Delivering water, sanitation and hygiene for all: A call for action. International Journal of Environmental Research and Public Health, 11(8), 7839–7855. https://doi.org/10.3390/ijerph110807839

Beaudeau, P. (2018). Time series analysis in environmental epidemiology: Applications to waterborne diseases. Environmental Health, 17(1), 1–10.

Chen, J., Jiang, X., Yan, Y., et al. (2022). Time-series preprocessing and ARIMA modeling for forecasting. Sensors, 22(3), 1–15.

Donkor, E. A., Mazzuchi, T. A., & Soyer, R. (2014). Urban water demand forecasting: Review of methods and models. Journal of Water Resources Planning and Management, 140(2), 146–159. https://doi.org/10.1061/(ASCE)WR.1943-5452.0000314

Ezbakhe, F., & Pérez-Foguet, A. (2019). Monitoring water, sanitation and hygiene: A review of uncertainty in global indicators. Science of the Total Environment, 687, 807–815.

Galaitsi, S., Russell, R., Bishara, A., Durant, J., Bogle, J., & Huber-Lee, A. (2016). Intermittent domestic water supply: A critical review and analysis of causal factors. Water, 8(7), 1–23.

Hopewell, M. R., & Graham, J. P. (2014). Trends in access to water supply and sanitation in sub-Saharan Africa. PLoS ONE, 9(10), e108222. https://doi.org/10.1371/journal.pone.0108222

Hutchings, P., Chan, M. Y., Naughton, C., Zimmer, A., & Moorthy, A. (2015). Achieving sustainability in rural water supply services. Water Resources Research, 51(10), 8400–8413.

Jeandron, A., Saidi, J. M., Kapama, A., Burhole, M., Birembano, F., Vandevelde, T., Ensink, J. H. J., & Cairncross, S. (2015). Water supply interruptions and waterborne disease: A time-series analysis. American Journal of Tropical Medicine and Hygiene, 93(1), 134–140.

Junttila, J. (2001). Structural breaks in time-series modeling. International Journal of Forecasting, 17(2), 263–276.

Kulinkina, A. V., Walther, B. A., Haas, C. N., Plummer, J. D., Younis, M. A., & Naumova, E. N. (2016). Water quality and health outcomes in rural communities. International Journal of Hygiene and Environmental Health, 219(7), 605–612.

Kostyla, C., Bain, R., Cronk, R., & Bartram, J. (2015). Seasonal variation of fecal contamination in drinking water sources. Environmental Science & Technology, 49(16), 9747–9756.

Moriarty, P., Smits, S., Butterworth, J., & Franceys, R. (2013). Trends in rural water supply: Towards a service delivery approach. Water Alternatives, 6(3), 329–349.

Omarova, A., Tussupova, K., Hjorth, P., Kalishev, M., & Dosmagambetova, R. (2019). Water supply challenges in rural areas of developing countries. Water, 11(5), 1–17.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. Econometrica, 57(6), 1361–1401. https://doi.org/10.2307/1913712

Viccione, G., Guarnaccia, C., Mancini, S., & Quartieri, J. (2020). ARIMA models for water forecasting. Water Supply, 20(3), 787–796.

Wang, W., Chau, K. W., Xu, D., & Chen, X. Y. (2015). ARIMA-based time series forecasting. Water Resources Management, 29(7), 2581–2594.

WHO/UNICEF. (2014). Progress on drinking water and sanitation: 2014 update. World Health Organization and UNICEF.

Yusof, F., Kane, I. L., & Yusop, Z. (2013). Structural break analysis in environmental time series. Hydrology and Earth System Sciences, 17(7), 2693–2704.

Zhang, J., Xiao, H., Li, J., & Shi, X. (2021). Structural breaks in water supply relationships. Agricultural Water Management, 245, 106599.