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Analysing the Impact of Water Access and Sanitation on Local Economic Development (LED) in the Sedibeng District Municipality, South Africa

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Globalization, climate change and increasing populations have put severe pressure on service delivery and water management in developing countries. This is not unique to South Africa, as the country is still plagued by significant inequalities and compromised service delivery relating to water access and sanitation. Despite these challenges, clean water and access to sufficient and safe sanitation facilities remain crucial for human health, food production, industrial output and social stability. As such, the main purpose of the study was to analyse the impact of water access and sanitation on local economic development (LED) within the Sedibeng District Municipality in South Africa. The study followed a quantitative approach using annual time series data between 1995 to 2018. Various econometric methods were employed including unit root tests, ARDL Bounds test for co-integration, an Error Correction Model (ECM) as well as Toda-Yamamoto granger causality tests. The results show the presence of both long and short run relationships between the dependent and independent variables. Having access to water facilities within households as well as quality sanitation contributes positively to the economic and social wellbeing of the region. Causality results further indicated a bi-directional relationship between water access and the local economic development index highlighting the interdependence of these aspects. The findings reiterate the significance of these resources to the wellbeing of the region. Not only does the access to these basic services contribute to the quality of life for many but its linkages within various economic domains such as diversification, energy utilization, employment and productivity make them vital drivers for the region's prosperity. As such, water and sanitation management should receive high priority in local stakeholders' policy agenda. Focus should be shifted to the implementation of sustainable water practices and improved sanitation infrastructure development to enhance the economic and social sustainability of the region.

Key words: *ARDL, local economic development, sanitation, Sedibeng, water.*
JEL Classification: *O10, O13, 018.*

Introduction

Over the past few years the world has experienced noteworthy growth in globalization, climate change and escalating populations. These changes have had alarming effects on various aspects of economies worldwide to which equitable access to water and sanitation has become a prominent concern (McMichael, 2013). This is particularly evident on the African continent, which despite attributing looming potential for economic growth and development, has had to endure major difficulties in providing these services to all its citizens (Economic Commission for Africa, 2017). The UN (2016) in fact contends that the continent's escalating population rate is expected to lead to growing demands for food to approximately 60 percent by the year 2050. This in turn has raised several questions regarding the capability of the continent's countries to satisfy escalating water demands. Whilst these aspects aren't usually at the forefront for policymakers towards improving the general economic performance, cognisance regarding the importance of these services not only towards improving the social outlooks for society but also the additional potential for diversification into the growth of non-traditional sectors has grown.

Access to quality water resources and the provision of effective sanitation in this regard therefore proves pivotal drivers for a more sustainable and safe environment on which inclusive and acceptable living standards can be provided (OECD, 2015). Adequate sanitation from this point of view refers to the ability of people to dispose waste safely, where facilities are not far from their immediate households and they do not have to endure long periods to get access to the facility (Chakravarty *et al.*, 2017). Similarly, quality water refers to drinkable resources that are clean and safe and also used in food preparation (Minh & Hung, 2018). Despite the increased awareness though, poor management of the infrastructure threatens the lives of people, especially those situated in the developing world, who are increasingly becoming more susceptible to diseases related to poor supply of these services (UN, 2018). Even after the inception of the sustainable development goals (SDG's), safe water and sanitation is still not a reality for approximately 30 percent of households globally (Khumalo, 2017).

As with most developing and emerging markets, South Africa is no exception to several socio-economic challenges (Meyer, Meyer & Neethling, 2016). For the past nine years a large part of the society has been plagued by lack of service delivery which has had devastating effects on more than half of the population living in poverty (Nkomo, 2017; Chang'ach, 2018). Notwithstanding the concerns of the current situation, the country, since its transition towards a democratic state, has made notable progress providing sanitation services to approximately 5.15 million households. However, despite this progress a large majority of geographically dispersed households still do not have access to sanitation facilities. In fact, approximately 35 per cent of households lack access to clean water and about 14.1 million South Africans are without proper sanitation (Department of Water and Sanitation, 2018). Whilst these point to a number of concerns relating to the fight against poverty, a continued emergence of the mismanagement of water has also inferred numerous consequences for the economy as a whole. Minh and Hung (2018) in this regard reiterate that the lack of improved water infrastructure has deterred the potential gains for employment growth in sectors such as tourism and agriculture (Zandi and Haseeb, 2019).

With this in mind, the implications for economic development progress, especially in more local regions, is undeniable. Whilst this has raised several concerns, research surrounding the relationship between water, sanitation and the linkages, both direct and indirect, with local economic development (LED) has been limited. It is against this background, that the study aims to contribute to the growing body of research in this particular field. As such, the main purpose of this study is to analyse the impact of adequate access to sanitation and water facilities in the Sedibeng District, a local developing region in South Africa.

Literature Review

Water is essential for life (Baguma *et al.* 2013), sanitation is dignity (SAHRC, 2014), and sufficient water supply and sanitation facilities are a necessity for human and economic development (Sullivan, 2002). Both access to clean water and safe sanitation facilities are acknowledged as human rights (UN, 2010) and more than that they assume a pivotal part towards food security, manufacturing production and output, adding to the growth and development of the economy (Hanjra & Qureshi, 2010). The significance of access to safe water and sanitation facilities has been echoed in the measurement of human development

(Sanusi, 2010), and in their inclusion in the Sustainable Development Goals (SDGs), further reflecting their importance towards the realisation of all human rights.

More so, is their significance has been expressed in a number of human rights treaties, both globally and locally. From an international perspective, Article 24(2c/d) under the Convention on the Rights of the Child (CRC, 1989) as well as Article 14(2h) of the Convention on the Elimination of all Forms of Discrimination against Women (CEDAW, 1979) forces states parties to through numerous measures to ensure children have access to safe environmental sanitation and clean drinking water, whilst furthermore providing guarantees to rural women regarding their "right to enjoy adequate living conditions, particularly in relation to housing, sanitation, electricity, water supply, transport and communication." Locally, both the African Charter on Human and People's Rights (1981) and the Charter on the Rights and Welfare of the Child (1990) likewise emphasises the importance of these services both to the social and economic progress of societies. Nevertheless, despite the cognisance of these aspects, many developing countries still struggle to improve access to these basic services, making economic development even more difficult to achieve (Engelman & LeRoy, 1993).

In this regard, the absence of access to harmless and adequate water and sanitation facilities devastatingly affects the wellbeing and dignity of many individuals, and has notable ramifications for the achievement of other human rights (PEP, 2006). The impact of water towards the reduction of poverty and the enhancement of the quality of life entails more than just drinking water and the adequate use of sanitation services. Water is critical for improved health and livelihoods of those that are underprivileged, ensuring the sustainability of the environment by lessening urban pollution and eliminating starvation. Equally important, according to WWAP (2015), is the fact that water indirectly has an effect on development, where the time and exertion spent on water collection, particularly from distant sources, limits individuals' wage generating ability and thus their contribution to crucial economic processes. In hindsight the impact of greater access and economic use of water resources and the associated sanitation services hold important implications particularly surrounding the reduction of poverty, the potential for job creation and the general improvement in the social wellbeing of societies.

The persistency of poverty in many parts of the world has changed how it has come to be perceived and likewise reduced. Modern perspectives have increasingly pronounced and emphasised the multidimensional nature of poverty (Sanusi, 2010). Indeed, in poor countries, poverty spreads across different dimensions, with the lack of water and sanitation facilities being one of them (World Bank, 2017). In fact, according to Sullivan (2002) where water poverty is pervasive, any approaches to lessen income poverty are not likely to be prosperous. Water poverty from these perspectives implies poor wellbeing ascribed to water (Cook & Gichuki, 2006), which as indicated by Sanusi (2010) is brought about by physical water shortage. From these perspectives, water is viewed as fundamental to various kinds of livelihood activities particularly farming (PEP, 2006). When clean water is constantly inaccessible, the deprived must devote an ample of their disposable earnings purchasing it, or great extent of time collecting it, which hampers development (Sorenson *et al.*, 2011). In light of the time spent in water collection rather than income producing exercises, people are denied of everyday compensation. In addition, frequent unfordable health expenses as a result of the ingestion of unclean water keep these families in endless poverty (Sorenson *et al.*, 2011). Similarly, agriculture and food security plays a critical role towards the improvement in local economic conditions. Ensuring that satisfactory and solid water supplies are accessible for farming activities is key towards improving the standard of living for most (PEP, 2006). Where there are constraints with regards to water and sanitation facilities, human development becomes hindered, inexplicably distressing the lives of low income households (World Bank, 2017).

Notwithstanding the importance of the aforementioned, water and sanitation access arguably play an equal or even more important role in employment and the diversification of economic activity. The UN (2016) reports that three of every four occupations in the global workforce rely upon water, suggesting that water deficiencies and issues of access to adequate sanitation could constrain economic progress and job creation. For women in particular this seems to be more prevalent. The gender aspect of employment indicates women (especially rural women) more than men to be increasingly influenced by an absence of access to water and sanitation (Curtis, 1998). Although both men and women play multiple roles (productive, reproductive, and community management) in society (Blackden & Bhanu, 1999), women as opposed to men, assume these roles concurrently and must therefore always try and balance challenging demands on restricted time for every one of them (Blackden & Wodon, 2006:1). The resulting implication from this is that women's labour force participation, especially in terms of work time and flexibility, becomes more constrained than is the situation for men. Nevertheless, for poorer communities and their corresponding developmental levels, Shaban (2008) and the UN (2016) contend that a large share lose their valuable time gathering water for their day by day needs, decreasing their participation in either the formal or informal sectors (WWAP, 2016).

Whilst this emphasises the impact on participation in economic processes, a more geographically dispersed access to these services likewise holds significant implications relating to an individual's skill acquisition. For instance, Blackden and Wodon (2006) explain that more time spent on acquiring the adequate water resources and the associated sanitation services will hinder the individual's ability to expand skills and competencies through education development. This is in turn will potentially affect the economic returns such as enhanced productivity gains and more specialised production processes for the society that could be obtained from the expanded human capital resources of regions.

Based on more macroeconomic perspectives, the WHO (2004) suggests countries with access to improved water and sanitation facilities experience greater economic growth, with annual growth on average exceeding 3.7 percent. Economic costs related to poor sanitation are ample, and encompass reduced income for a region, particularly from the tourism sector (which experiences reduced tourist due to the increased risk of infection and diseases) (WHO, 2008). This has significant effects on employment given that the tourism sector is usually one of the most labour intensive sectors. Empirical evidence in this regard has undoubtedly supported these claims. In fact, in Indonesia, it was found that poor sanitation results in extensive welfare losses, tourism and environmental losses resulting from loss of productive land (Napitupulu & Hutton, 2008). Furthermore, various studies have also shown positive associations between water related investments and economic growth. A study in the United States found that for every US$1 million spent on investments in water infrastructure an estimated 10 to 26 additional sustainable employment opportunities were generated (Pacific Institute, 2013). Additionally, small-scale investments aimed at providing access to safe water and basic sanitation in Africa could offer an estimated economic return of at least five per cent of gross domestic product (GDP).

Whilst the aforementioned predominantly revolves around the economic consequences regarding water shortages and inadequate sanitation services, these inefficiencies are also closely related to the social dimension of local economic development (LED). Fink *et al.* (2011) in fact describe the consequences of lacking access to water and sanitation as severe, particularly for child development. In their report the UN (2010) contend that of 2 million work-related deaths every year, nearly one-in-five are caused by poor quality drinking water, inadequate sanitation and poor hygiene. When water is limited, diseases are more prevalent which in turn can potentially lead to unsanitary and inappropriate living conditions (Sorenson *et al.*, 2011). In this regard water and sanitation acts as a pivotal pillar towards ensuring a healthy and sustainable living environment, henceforth contributing immensely towards improved economic and social wellbeing for communities, region and nations alike. A recent paper by Shandra *et al.* (2011) also supports this as it demonstrated that higher levels of access to an improved water source and sanitation facility are associated with lower levels of child mortality within Sub-Saharan African nations. Sommer *et al.* (2015) also found similar results in 32 Sub-Saharan African countries which saw decreased maternal and neo-natal mortality for regions with more accessible water resources as well as better hygienically orientated sanitation infrastructure.

Furthermore, based on the impact of these aspects have on both communities' economic and social dimensions, a study by the WHO (2012) found that meeting the targets in the Millennium development goals (now referred to as the SDGs) on water and sanitation alone would save 3.2 billion adult employment opportunities globally and 443 million school days annually, increasing labour force output and enduring earning prospects, especially for girls (Hutton, 2012; Castro, 2018). These findings are further reiterated by the World Bank (2017) which emphasises that improving access to water and sanitation can aid in protecting the fundamentals of regional progress by supporting nutrition (addressed by SDG 2) and health (addressed by SDG 3), both which are crucial pillars of sustainable human development.

Research Methodology

Research design and sample period

The study followed a quantitative research approach through the use of annual secondary data. The sample period ranged from 1995 to 2017 (based on annual observations) with the purpose of ascertaining the impact of the progress on water access and sanitation provision has had on economic development levels within the region since the transition to democracy. Included variables comprised quality water access measured through the percentage of households with piped water inside their household structures and sanitation levels measured by the percentage of households that had access to a flush or chemical toilet and also received regular household refuse removal services. A local economic development index ranging from 0 to 100 was used to measure the area's developmental levels derived from the index as used by Meyer and de Jongh (2018). All data were obtained from the Quantec database. A total of four constituent variables were used where each carried an equal weight. This included the Human Development Index (HDI), poverty rates (using international threshold of $1.90 per capita), employment rates and the Gini index. Each of the indicators were converted with the purpose of ensuring the analytical soundness of the composite measure. These conversions and the corresponding interpretations are shown in Table 1 below. After all variables were converted both the dependent and independent variables were transformed into their natural logarithms in order to measure the responsiveness and elasticities between these factors.

Table 1: LED index constituent indicators' conversion and interpretation

Variable	Conversion	Interpretation
Human Development Index (HDI)	HDI x 100	Expresses the level of human development with a score between 0 – 100 where higher scores indicate higher levels of human development.
Poverty rates (%) (International threshold - $1.90)	100 – poverty rate	Indicates the percentage of the population that are above the upper bound poverty line. Higher percentages infer more people that are not considered impoverished.
Unemployment rate (%) (Strict definition)	100 – unemployment rate	Score between 0 – 100, shows an employment rate of the labour force. Higher scores indicate more people obtaining employment.
Gini index	100 – Gini index score	Inverse of the Gini index. Higher scores suggest a more equal income and resource distribution within the social structures of the population.

Model specification

For the purpose of analysing both the short- and long run relationships between the variables under consideration, the study utilised the autoregressive distribute lag (ARDL) model. The model as opposed to the Johanssen co-integration model holds the ability to analyse the different relationships between variables regardless of whether they are stationary at level or integrated at the first order. However, their applicability limits the use of variables which are integrated at second order. Nevertheless, the selection of the model was mainly driven by its ability to provide robust results even when samples are small whilst simultaneously analysing both the short and long run relationship between the variables under consideration (Hua, 2016). In line with the model, the analysed function is represented as follows:

$$\ln LED = f(\ln WA; \ln SANI)$$
……………………………………………………………………….. (1)

Where, lnLED is the natural logarithm of the local economic development index; lnWA the natural logarithm of the levels of quality water access and lnSANI the natural logarithm of the level of sanitation provision inherent in the selected area. Based on this function, the ARDL model can then be represented as follows:

$$\Delta \ln LED = \phi_0 + \sum_{j=1}^{k} \beta_j \Delta \ln LED_{t-j} + \sum_{j=1}^{k} \lambda_j \Delta \ln WA_{t-j} + \sum_{j=1}^{k} \varphi_j \Delta \ln SANI_{t-j} + \omega_l \ln LED_{t-1}$$
$$+ \omega_2 \ln WA_{t-1} + \omega_3 \ln SANI_{t-1} + \mu_t$$
………………………………………………………………... (2)

Where ϕ_1 is the drift component, k represents the total number of lags and μ_t the white noise residuals. The symbols β_j, λ_j and φ_j all represent the short run dynamics regarding the changes of the included variables, whereas ω_1, ω_2 and ω_3 are indicative of the long run coefficients. Given the aforementioned model (as presented in equation 2), the study subsequently employs the bounds testing procedure of co-integration as developed by Pesaran *et al.* (2001) to test the following hypotheses:

Null hypothesis: No-co-integration - $\omega_1 = \omega_2 = \omega_3 = 0$
Alternative hypothesis: Co-integration of the variables - $\omega_1 \neq \omega_2 \neq \omega_3 \neq 0$

The testing procedure relies on a calculated Wald F-statistic. The statistic is compared to both lower and upper bound critical values which are provided by Pesaran *et al.* (2001). If the calculated statistic is found to exceed the upper bound critical values, it is indicative of the presence of co-integration among the variables or the rejection of the null hypothesis specified above. However, if the calculated F-statistic is lower than the lower bound critical values the null hypothesis cannot be rejected. After the procedure is completed, and if the test statistic does exceed upper bound critical values Pesaran *et al.* (2001) suggests the use of an unrestricted error correction model (ECM) with the purpose of measuring the speed of adjustment to equilibrium. The model as used is expressed in equation 3 below:

$$\Delta \ln LED_t = \phi_0 + \sum_{j=1}^{k} \beta_j \Delta \ln LED_{t-j} + \sum_{j=1}^{k} \lambda_j \Delta \ln WA_{t-j} + \sum_{j=1}^{k} \varphi_j \Delta \ln SANI_{t-j} + \vartheta ECT_{t-1} + \mu_t$$
…… (3)

Here, ECT shows the error correction term and ϑ the ECT speed of adjustment indicator. Towards applying this specific ARDL model the EViews 9 software was used which also allowed for automatic optimal lag selection based on the Akaike Information Criterion (AIC). As the final part of the analysis the study additionally employed causality analysis through the use of the Toda-Yamamoto non-granger causality approach. This was primarily based on the presented evidence from previous studies on the possible causal link between the variables (Anderson & Hagos, 2008; Danti, 2017). This specific approach was selected as opposed to the Granger (1969) causality test as the latter assumes that variables are integrated of the same order. Therefore, if variables are integrated of different order the estimated results might be unreliable (Mavrotas & Kelly, 2001). The Toda-Yamamoto approach, contrastingly is deemed more appropriate when variables are integrated of different order. It makes use of an unrestricted regression and modified Wald test to test whether there is no causality present amongst the variables. It does this by testing whether the coefficients lagged values of each of the included variables is zero (H_0). If this null hypothesis is rejected and coefficients of the lagged values of the variables are not equal to zero, this suggests a causal link between the selected factors.

Results and Discussion

Correlation analysis

As first step in the analysis, Table 2 presents the correlation results. From these estimates it shows that the logarithm of the local economic development (LED) index is positively associated with the logarithmic form of the region's level of water access. A correlation coefficient of 0.3 infers the relationship to be relatively weak. Similarly, logarithm levels of adequate sanitation provision also show a positive, yet week relationship (*c = 0.22*62) with the constructed development index. Contrasting to these relatively weak relationships, quality water access and sanitation show strong correlations with a correlation coefficient of 0.90. In fact, this relationship is deemed statistically significant at a 1 percent level of significance given the high t-statistic (*t-stat. = 40.116*) and low p-value of 0.000. This essentially highlights the strong interdependence among these services, especially in more local conditions (Mulopo, 2015).

Table 2: Correlation coefficients for the variables under consideration

Variable	lnDEV	lnWA	lnSANI
lnLED	1.000000 ----- -----		
lnWA	0.308881 [1.452379] (0.1619)	1.000000 ----- -----	
lnSANI	0.226185 [1.038440] (0.3115)	0.903843 [40.11582] (0.0000)*	1.000000 ----- -----

Note: *[ ] represents t-statistics and ( ) significance values; * denotes significance at 5% level of significance*

Unit root tests

Given that ARDL models are highly likely to present spurious results when included variables are stationary at I(2), the study employed a unit root testing procedure using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests with the purpose of ensuring a robust analysis. Results for both these tests are presented in Table 3 below. From these estimates it shows that both tests are in agreement. At level, significance values for both the lnLED and lnWA variables are greater than 0.05 with and without intercept, henceforth the null hypothesis (has unit root) cannot be rejected. However, at first difference both p-values for these values are less than 0.05 suggesting that these variables are integrated at first order. Results for lnSANI *(sig. values = 0.000)* for both the PP and ADF tests at levels suggest that the variable is I(0). As the results indicate no presence of any variables integrated of the second order, the subsequent step is to estimate the bounds testing procedure in order to analyze the long-run dynamics between the selected variables.

Table 3: ADF and PP unit root tests results

Test	Variable	Levels				1st difference				Result
		Intercept		Trend & intercept		Intercept		Trend & intercept		
ADF	**lnLED**	-2.2114	0.2088	-1.5455	0.7797	-3.0443	0.0478*	-4.1260	0.0207*	I(1)
	lnWA	-2.0426	0.2679	-1.3574	0.8434	-2.9822	0.0539	-4.2210	0.0172*	I(1)
	lnSANI	-2.5629	0.1160	-8.1001	0.0000*	-16.300	0.000*	-15.637	0.0001*	I(0)
PP	**lnLED**	-2.1006	0.2463	-1.5443	0.7802	-3.0690	0.0455*	-4.1266	0.0206*	I(1)
	lnWA	-2.3143	0.1500	-1.2623	0.8692	-3.1507	0.0387*	-4.1309	0.0205*	I(1)
	lnSANI	-2.3817	0.1585	-6.637	0.0000*	-3.577	0.0163*	-3.6315	0.0525	I(0)

*Note: * denotes significance at 5% level of significance*

ARDL bounds test and long run integration

The study made use of the bounds testing procedure with an ARDL model (2,3,4) chosen through the use of the Akaike Information criteria (AIC). The results of the bounds test are presented in Table 4. The estimated F-statistic of 7.287 is shown to exceed the upper bound I(1) threshold of 5 at the 1% significance level suggesting that the null hypothesis of no co-integration is rejected. Based on these results there does seem to be a long-run relationship between local economic development (LED) levels within the region and the community's access to quality water and the provision of sanitation services.

Table 4: ARDL bounds test results

Test-statistic	**Value**	**k**
F-statistic	7.286688	2
Critical value bounds (sig.)	**I(0) Bound**	**I(1) Bound**
10%	2.63	3.35
5%	3.1	3.87
2.5%	3.55	4.38
1%	4.13	5

Given that there exists a long-run relationship between the variables as shown by the results in Table 3, it is imperative to further investigate the coefficients amongst these variables with the purpose of gaining un understanding of the direction of these relationships and their elasticity. Equation 4 subsequently depicts these estimates showcasing that having both access to water as well as sanitation contributes positively to both the social and economic standards of living for the region. This finding is also in line with similar studies of Frone and Frone (2014) as well as Gnade *et al.* (2016).

$$\ln LED = 1.0631 + 0.467 \ln WA + 0.638 \ln SANI \qquad (4)$$

From Equation 4, it shows that a one percent increase in the number of households with piped water access subsequently will contribute towards 0.467 percent increase in local economic development levels. Furthermore, a one percent increase in the number of households with access to regular refuse removal services as well chemical toiletry infrastructure contributes approximately 0.638 percent towards the constructed local economic development index.

Error Correction model (ECM) results and short run relationship analysis

With the existence of co-integration among the variables, the following phase in the analysis procedure should entail the use of an error correction model with the purpose of ascertaining short-run adjustments towards the long-run equilibrium (Gujarati, 1995). The results of this specific analysis are depicted in Table 5 below. As prerequisite for the explanation of these adjustments, Mukhtar and Rasheed (2010) prescribe the presence of a negative and significant error term coefficient. As shown from Table 5, the CointEq(-1) attributes a coefficient of -0.607 together with a t-statistic of -6.6121. Based on these estimates, results shown in Table 4 provide robust evidence of the short-run dynamics between the variables and the explanation of their movements with regards to the co-integrating equation.

Table 5: Error correction model results depicting short-run dynamics of the variables

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(lnLED(-1))	0.865321	0.163052	5.307023	0.0018*
D(lnWA)	0.595520	0.223465	2.664939	0.0373*
D(lnWA(-1))	0.596578	0.244552	2.439475	0.0505
D(lnWA(-2))	0.701300	0.190587	3.679684	0.0103*
D(lnSANI)	0.596561	0.278734	5.727897	0.0012*
D(lnSANI(-1))	0.911242	0.184149	5.491434	0.0015*
D(lnSANI(-2))	0.022369	0.180123	0.124187	0.9052
D(lnSANI(-3))	0.118811	0.221924	5.041411	0.0024*
CointEq(-1)	**-0.607941**	**0.091943**	**-6.612120**	**0.0006***

*Note: * denotes significance at 5% level of significance*

From the short-run estimates shown in Table 5, it is clear that current LED levels are significantly influenced by its own previous levels, together with the levels of water access (*coeff. = 0.595; p-value = 0.0373*) present in the region. In addition to these results, the coefficient for lnSANI infers that a one percent increase in the number of households with adequate sanitation services increases short term economic development levels by approximately 0.596 percent. These estimates therefore highlight the multidimensionality of economic development as a process. Not only do these aspects contribute to the enhancement of the social environment but their linkages to the aspects such as diversification, employment, productivity gains and better educational access underlines their contribution to improving the regional economic outlook (Meeks, 2017). Finally based on the error correction term, approximately 60.7 percent of the deviations caused by changes in the water access levels as well as sanitation provision are corrected each quarter. Alternatively, these results indicate that it takes approximately 1.644 quarters for the changes in water access and sanitation to have a full effect on the prevailing economic development levels within the Sedibeng region.

Toda-Yamamoto granger causality analysis

With the existence of a co-integrating relationship confirmed in sections 4.3 and 4.4, this suggests that there should be causality amongst the variables in at least one specific direction (Tursoy & Faisal, 2016). In line with this, the study made use of the Toda-Yamamoto granger causality approach as variables were found to be integrated of a different order. The results for the test are shown in Table 6. The estimates showcase bidirectional causality between both having access to water and the prevalent local economic development levels. These results reiterate the endogenous nature of having access to water towards driving improvement in various economic and social aspects of communities (Kodongo & Ojah, 2017). Furthermore, improvement in general economic dimensions exogenously causes water infrastructural improvements allowing access to more geographically dispersed and rurally located areas. Similar results are also reported for the levels of sanitation service provision and water access highlighting the various hygienic and health relates properties of these factors (Mulopo, 2015). Upon viewing the relationship between the lnSANI and lnLED it is evident that only a unidirectional relationship exists which emanates from local developmental factors.

Table 6: Toda-Yamamoto granger causality test results (chi-square values and p-values)

Excluded lags	Dependent variable		
	lnLED	**lnWA**	**lnSANI**
lnLED	-----------------	40.64233 (0.000*)	10.8259 (0.029*)
lnWA	16.8741 (0.002*)	-------------------	26.916 (0.000*)
lnSANI	0.9811 (0.9126)	54.3936 (0.000*)	-----------------

Note: *( ) depicts the significance values; * denotes significance at 5% significance level*

Diagnostic and stability tests

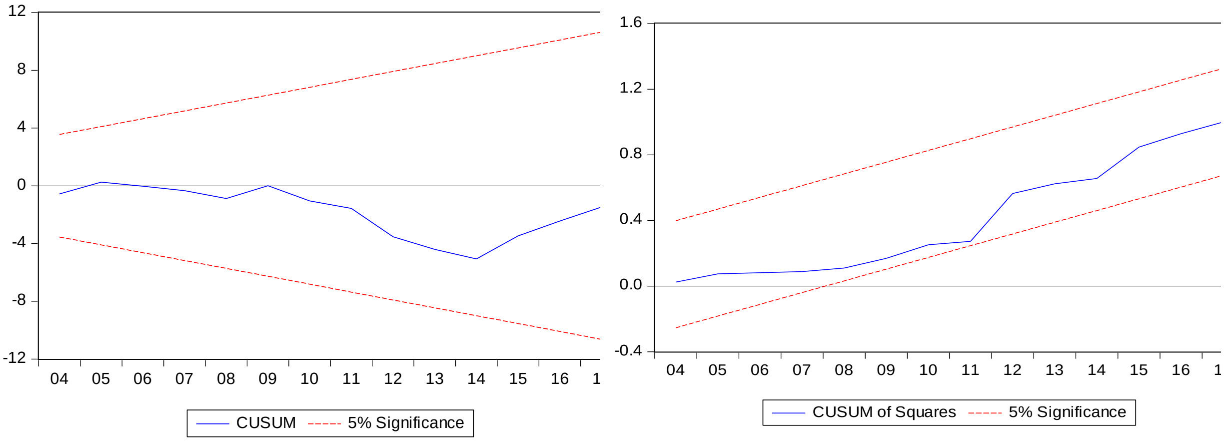
In order to ensure the robustness of the used models as well as to confirm the validity and reliability of the estimation, various diagnostic tests were conducted. Utilised tests included the Jarque-Bera normality test, White's test for heteroscedasticity as well as the Breusch-Godfrey serial correlation test. The results for these tests are depicted in Table 7. Upon viewing the results of the tests it can be concluded that none of the underlining statistical assumptions were violated.

Table 7: Various diagnostic test results and their interpretation

Test	**Null hypothesis (H_0)**	**Tests statistic**	**p-value**	**Results**
Jarque-Bera normality test	Normality in residuals	1.8272	0.4011	Do not reject H_0
Breusch-Godfrey-Pagan Heteroscedasticity test	No conditional heteroscedasticity	1.1299	0.3649	Do not reject H_0
Breusch-Godfrey Serial correlation LM test	No serial correlation	0.434	0.8903	Do not reject H_0

Finally, with the purpose of ascertaining whether the used models exhibited parameter stability through the sample period both CUSUM and CUSUM of squares stability tests were conducted. With the results of these tests depicted in Figure1, it would seem that both models exuded dynamic stability as both remained within the upper and lower critical boundaries. This therefore suggests that the relationship between local economic development access to water as well as the level of sanitation service provision was consistent throughout the period under investigation. Henceforth, this confirms that any possible alteration in economic stability during 1995 to 2017 did not have a significant impact on the selected variables' association.

Figure 1. CUSUM and CUSUM of squares stability tests



Conclusion and Recommendations

The primary aim of this study was to analyse the impact that the access to adequate water supply and sanitation has on economic development in a local developing region. Based on the results as presented both water access and sanitation seems to play a significant role in the economic as well as social wellbeing of the Sedibeng region. Not only does access to these services contribute to a healthier and sanitary environment, but water in particular is repetitively shown to be an important economic resource that if managed prudently and effectively could assist in driving various social objectives of communities. As the study has shown, this holds particular relevance and various implications for certain domains including poverty reduction, skills development, employment creation, economic diversification and the overall improvement in the underlining health status of individuals. In addition, the study also provides sufficient evidence concerning how these processes are intertwined. Thus, as much as water and sanitation infrastructure growth drives economic development, there does exist mutual interdependency. This further emphasises the role that key stakeholders and policymakers play in this process.

Henceforth, for South Africa to realise its outlined development objectives especially in local communities, clear cognisance needs to be fostered regarding the importance of the management and investment of water resources and the associated service delivery measures that go with it. For the Sedibeng region in particular, classified as a water rich area, the social as well as economic potential of water is not realised or prioritized. It is therefore recommended that local and provincial government provide the necessary support to allow for prudent maintenance of all water and sanitation related infrastructure. More sustainable approaches need to be incorporated in managing these resources with the aim to increase capacity, improve access especially in geographically disbursed areas as well as taking advantage of the various diversification processes these services bring with it. In this light, a multifaceted approach is required, one where all community stakeholders must realize their responsibility in ensuring a safe and sustainable environment for businesses, households and communities as a whole.

Whilst this study has shed light on the limited empirical evidence surrounding the relationship between water, sanitation and economic development it is not without its limitations. These predominantly revolve around the subjectivity in indicator selection of the constructed index, data availability and the analysis on a single district region within South Africa. Nevertheless, despite these shortcomings, it does provide an opportunity on which future studies can add that can include the use of panel analyses, incorporating various district areas to obtain a more holistic view of these relationships as well as the application of a more objective weighting procedure in constructing the used composite index.

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