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Sustainability of Rural Communities Drinking Water Systems and Local Development Projects in the Bole, West and Central Gonja Districts of the Savannah Region, Ghana

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ABSTRACT

This study employed the post-positivist epistemology and the cross-sectional survey to examine the factors influencing the sustainability of communities drinking water and local development projects in the Bole, West and Central Gonja Districts of the Savannah Region, Ghana. Proportionate, systematic and simple random techniques were utilised to sample 450 respondents, composed of 392 household heads and 58 officials. Data was collected, utilising self-designed and semi-structured face-to-face interviews and questionnaires. Correlation and regressions were generated to determine relationships between the variables. Results showed community participation ($r= 0.576$, p-value $= 0.019$), finance ($r = 0.517$, p-value $=$ 0.006), sense of ownership ($r = 0.573$, p-value $= 0.012$), labour support ($r = 0.474$, p-value $=$ 0.015), education ($r = 0.469$, p-value $= 0.021$), technology ($r = -\ 0.436$, p-value $= 0.018$), maintenance ($r = -0.503$, p-value $= 0.029$), water pollution ($r = -\ 0.389$, p-value $=0.041$) and transparency ($r = -\ 0.250$, p-value $= 0.015$), were significantly associated with water projects sustainability. 69.7 percent of variabilities were collectively explained by the independent variables. Since p-values were $< \alpha = 0.05$, the null hypothesis (Ho) was ruled out in favour of the alternative hypothesis. With strong participation, funding, local ownership, labour, and citizen empowerment, coupled with improved facility maintenance, appropriate technologies, pollution control and good eco-governance, there is almost irresistible likelihood for water and development projects to be sustainable. Depoliticising water, democratisation and eco-friendly strategies are necessary preconditions for an inclusive, self-governing and ecologically responsible citizenship needed for sustainability of water projects at the lowest level of development.

Keywords: Sustainability, Community Drinking Water, Sustainable Development, Savannah Region, Ghana.
JEL Classification: Q01, Q20. Q28, Q42, Q48

1. Introduction

The effective operation and management of rural water resources and sanitation services requires suitable capacities, including technology, human resources, eco-friendly policies, adequate

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financial resources and local community support, particularly for establishment of new infrastructure, maintenance, repair and replacement of either malfunctioning or obsolete facilities. This ensures safe drinking water delivery, maintenance of service quality over time (Schouten & Moriarty, 2003), futurity and availability of water and intergenerational fairness among populations (Neil, 2007). The sustainability of water refers to the continues capacity of water facilities to provide short, medium to long term environmental, social and economic benefits, maintain human-ecological balance and conservation of ecological systems for posterity (Kinyanjui and Wanyoike, 2016). Nevertheless, due to high costs of operation and maintenance, the management and expansion of water supply projects become a challenge to many local authorities (Department of Water and Sanitation-DWS, 2015). Moreover, endemic poverty, low tariffs of water and fees for rural sanitation services do not seem to generate sufficient income to sustain the rural water and sanitation sectors (WHO & UNICEF, 2000). In Ghana, the operation and maintenance (O&M) practices for rural water sources remain poor and many gravity flow schemes and point water sources are not fully operational (Morinville & Harris, 2014). Moreover, post-construction monitoring, and technical support gaps exist at the district and rural level, with the district water offices focusing more on construction and less on maintenance. The benchmark of the Smart Development Work (2018) indicates that a sustainable water source (piped/borehole scheme) should provide water for a minimum of 350 days in a year with less than 14 days of breakdown. In Ghana, very few water sources (piped/boreholes) are able to meet this standard and a broken-down water source can take up to 12 months or more before it is repaired (Bathsheba, 2011). On average, a water source functions well within the first three years, after which it starts breaking down (Yire, 2015). The majority of rural water sources are not regularly maintained and hence at risk of regular breakdowns, meanwhile, political commitment in construction and maintenance of existing water supply schemes is demonstrated mostly during an election year (Manu, 2015). Beyond the poor culture of maintenance is the lack of transparent and local accountability structures, community sense of ownership and lack of water quality test, especially for water schemes serving rural communities. Again, the excessive interference by governments and politicians in rural water supply and development projects basically for political expediencies (Addo, 2010) is worrisome. Short-term rural water policies and tariff setting are influenced by politicians (Bohman, 2010), while the selection of beneficiary communities for award of water schemes and membership composition of water boards/committees are riddled with political patronage (Doe, 2007).

Though significant strides have been achieved in post-construction maintenance of urban water supply facilities, which are periodically rehabilitated by the Ghana Water Company (GWC) in liaison with private operators, Community Water and Sanitation Agency (CWSA), Public Utility Regulatory Commission (PURC) and Ministry of Water Resource, Works and Housing (MWRWH), narratives of similar progress are yet to be concretely registered for the community and rural water supply sector (CWSA, 2015). Undeniably, clean water and sanitation are essential human rights which are key to everyday life and development of human populace, regardless of their locations, livelihood and social status. A deprivation of drinking water is perilous to human life, yet, while population soars, access to water and sanitation presents a different narrative and this is more pronounced in rural communities of Savannah area of Ghana, where the lack of maintenance of water facilities poses a challenge and threat to water sustainability (MWRWH, 2012). This could affect the Sustainable Development Goals (SDGs) implementation (United Nations, 2015) and Ghana's vision of achieving universal access to potable water and sanitation for all by 2030 (CWSA, 2015).

1.1 Problem statement and study justification

The construction of potable water projects in rural areas is an essential step to increase community water access, resilience and contribute to the healthy growth and development of its members. Aspects of water supply systems that promote sustainability but need improvement include better planning and follow ups, democratisation and local participation, better operation, maintenance, and management. Though sustainability of rural water supply projects and the benefits they deliver to local communities are some of the overriding concerns to the rural sector, yet these essential activities appear to have been either obliterated or seriously lacking among districts and communities. It appears limited emphasis has been placed on challenges that undermine long term sustainability of rural water supply projects, before, during and after the post-implementation phases of such projects. Hence, the veracity and effects of the challenges have not been properly understood and contextualised. Albeit some studies have been done on water sustainability in rural Savaanah, the focus have largely been concentrated on isolated rural-based water projects funded by non-governmental organisations. Moreover, no comprehensive rural ecologically-driven study has been sighted on water sustainability among the selected case study areas which are the focus of this current study. This study has become useful as it provides sufficient information to stakeholders before, during and after launching large investments in rural water supply projects. Moreover, this study serves as a baseline for discourse on water projects sustainability and adaptations to ecological variabilities in order to preserve ecosystems and the quality of livelihoods among rural dwellers. In addition, an assessment of constraints to portable water sustainability brings to the forefront, the need for ecological policy measures and enabling capacities for effective water resource management to forestall possible future challenges among historically underserved and margenalised rural settings. A critical assessment of the challenges of sustainable rural potable water projects particularly at the pre and post-construction phases is not only a considered priority for the Savannah region, but of equal importance is to guarantee public safety, securitisation and water resilience particularly for peripheral areas including the Bole, Central (Buipe) and West Gonja (Damongo) Districts, which are noted to be water margenalised and hydrologically challenged in Ghana.

1.2 Study hypothesis and variables

1.2.1 Null Hypothesis (H0):

The null hypothesizes (H0) for this study assumed that “there is no statistically significant relationship between participation, finance, periodic accountability, technological capacity, periodic maintenance, water pollution, education and training, labour support, communities sense of projects ownership (X-independent variables) and the sustainability of drinking water projects at the lowest (micro) level of development (Y-dependent variable)”.

1.2.2 Alternative Hypothesis (H1):

The alternative hypothesis (H1) was an inverse or opposite of the null hypothesis, which assumed that indeed “there is a statistically significant relationship between participation, finance, periodic accountability, technological capacity, periodic maintenance, water pollution, education and training, labour support, communities sense of projects ownership (X- independent variables) and the sustainability of drinking water projects (Y-dependent variable) at the lowest or micro level of development”. The alternative hypothesis assumed that at least one or more of the independent variables (Xs’) “is useful” for explaining or predicting the depending variable (Y).

2. Theoretical and empirical perspectives

There have been divergent models, perceptions and theoretical narratives on sustainability of water and development projects at the lowest level of governance. In an endeavour to give a broader picture of the subject under investigation, this study placed the research problem within a broader politico-ecological tradition of enquiry, on-going water dialogue and within the context of related studies. This put the study into its proper perspective, while demonstrating state of the art and enabling the researcher to learn and profit from successes and shortcomings of others who tackled similar social problems. From the democrats and green ecological perspectives, considerations for self-governing and democratic systems including community participation (Baffoe-Bonnie et. al., 2008), good governance (Neil, 2007), gender balance and community empowerment (training) (Roger & Hall, 2003) are necessary measures for inclusive decision-making (Wrong, 1979) and effective operation of rural water facilities (Calow et al., 2009). Others have laid emphasis on decentralisation (Oates, 1972; Olowu and Wunsch, 2004) and community management approaches (Schouten and Moriarty003) as pathways to development sustainability as it transfers resources and enabling capacities which affords localities to own-manage social amenities locally. Romano (2013) extends the debate further by arguing that able management and financial factors constitute essential determinants for water sustainability in rural settlements. Besides, human resource support and empowerment of local citizens are found to positively affect water delivery efficiencies and performance as it improves planning, implementation, monitoring and evaluation of water and sanitation projects (Waithaka, 2013). Similarly, Haysom (2006) indicates that the ever-changing water consumption trends and ecological variabilities should serve as sign-post towards the adoption of suitable technologies and appropriate conservation policy measures in rural Tanzania. Iribarnegaray and Seghezzo (2012) extend the debate further by arguing that, the challenges with water operation and sustainability of development facilities are phenomenally a reflection of institutional and governance failures. The rural water and sanitation sector must adopt measures for ensuring transparency, accountability and active engagement of local stakeholders in the operation, management and decision-making processes of water and sanitation projects (Allan, 2011; Awoke, 2012). Besides, symmetrical information required by stakeholders for policy decisions must be made accessible and easily understandable by all rural populations (Lencha, 2013). This is essential since a robust community and rural water sector depend on information, commitment to effective operation and management (O&M) of facilities.

Moreover, an appraisal of the avalanche of contrasting empirical narratives is not only considered imperative but provides an apriorism for understanding the social context and the indicators of water projects. In Nyahururu sub-county of Kenya, Kinyanjui and Wanyoike (2016) found strong positive correlation between; financial capacity/water tariffs ($r = 0.759$, Sig. = 0.00, N=60), community participation ($r = 0.839$, Sig.= 0.053, N=60), project management capacity ($r = 0.658$, Sig.= 0.065, N=60), human resources ($r=0.754$, Sig.=0.037, N=60), facility. rehabilitation/maintenance/repairs ($r = 0.934$, Sig. = 0.00, N=60), pollution ($r = 0.898$, Sig.= 0.052, N = 60), technological capacity ($r = 0.769$, Sig.= 0.041, N=60). Again, an inversely strong negative correlation was observed between good governance ($r = -0.745$, Sig. = 0.052, N=60), transparency/accountability ($r = -0.545$, Sig.= 0.00, N=60) and water distribution systems ($r = -0.585$, Sig. = 0.56, N=60) (Kinyanjui & Wanyoike, 2016: 24). Similarly, Aharikundira, Mushabe, Tibanyedera and Namukasa (2015) discovered that in rural Kampala, technology and technically competent human resources are essential for competitive market edge and sustainability of community-based water resource management. Technology is required for improving water accessibility, infrastructure, purification, distribution efficiencies and disposal of waste in rural poor settlements.

Similarly, Lencha (2013) found that in rural settlements of Ethiopia, technical know-how and development is critical to achieve sustainability within water and sanitation deliver systems. Technology was found to be positively correlated with water service reliability, cost of production, and quality of water, infrastructure and distribution trends. In a multiple regression analysis which determined the most influential determinants or predictors (finance, human resource, drought, local participation and technology) on water sustainability, Kinyanjui et al., (2016) discovered that {r=0.7654(a), r2 (r-square)= 0.586, adjusted r-square= 0.530, and std. error of the estimate = 0.3868}, which meant that six of the predictors/independent variables explained approximately 56.6% of the variation in the sustainability of rural water supply of the Nyahururu sub-county. Since the observed variability in the Analysis of Variance (ANOVA) had {f-statistic = 2.7034, with sig. = 0.05, $\alpha = 0.05$}, the study concluded the existence of regressional relationship with statistically significant associations between the predictor variables and the predicted/dependent variables (Kinyanjui, et. al., 2016). Meanwhile, in a related study in the Brong Ahafo and Volta Regions of Ghana, Marks, Komive and Davis (2014) found that households participation during meetings (p-value = 0.04; $\alpha < 0.01$; n=176), involvement in technical decisions (p-value = 0.6; $\alpha < 0.01$; n=176) and labour contribution to handpump construction (p-value = 0.07; $\alpha < 0.01$; n=176), were each strongly and positively associated with poorer handpump platform infrastructure in both regions. However, handpump infrastructure were likely to provide quality water outcomes when all other variables were else held constant, particularly; in communities where poorer households had been comparatively more engaged in technical ($\alpha < 0.01$) and management related decision-making processes ($\alpha < 0.01$), with some technical support ($\alpha < 0.01$) from the districts water teams. Cash contributions by households (p-value= -0.06; $\alpha < 0.01$; n=176) and impact of the dry season (p-value= -0.07; $\alpha < 0.01$; n=176), were negatively associated with the functionality and condition of handpump infrastructure, even though the associations were statistically insignificant (Marks et al., 2014: 10)

Similarly, in Kenya, Marks, Onda and Davis (2013) studied the functionality of piped systems which served between 500 and 8000 rural household populations. The study discovered that due to the dispersed settlement patterns across the population and within the study provinces, pipeborn water supply reached approximately 60 percent of households in each community. The socio-economic and demographic indicators showed that water committee members were on average;

"10 years older than household survey respondents (Student's $t = 9.1$; $\alpha < 0.01$; $df = 2{,}225$), and a greater share have completed primary school (Student's $t = 5.6$; $\alpha < 0.01$, $df = 2{,}225$). A regression analysis found that at the community level, the sense of ownership among households was statistically significant and negatively correlated with water committee members (p-value= 0.39; $\alpha < 0.01$; $n = 313$) (Marks et al., 2013: 127).

Nonetheless, when all the other variables were held constant, households' sense of ownership was positively and significantly associated with user confidence in water services and sustainable water system management ($\alpha < 0.01$), while water committee members' sense of ownership is positively associated with infrastructure condition, but only marginally significant (p-value = 0.08; $\alpha < 0.01$; $n = 313$). Water projects that were initiated through community level organising, rather than through the effort of an external group had significantly lower user confidence scores ($\alpha < 0.01$), when all other variables were held constant (Marks et al., 2013: 130). In terms of climate, the prolonged dry seasons experienced by rural poor communities and villages in Africa, adversely affect the availability of rainwater or runoff and ground water resources including boreholes, wells or springs, which could serve as a buffer for short-term environmental variability and evaporation of surface water resources (MacDonald & Calow, 2007). The rainfall patterns across Africa have been highly variable. Droughts are becoming endemic in Africa and the extent of drought-affected areas is increasing (Sheffield & Wood, 2008). There is observed increase in water demand during droughts in Southern Africa in the early 1990s (Calow et al., 1997), droughts in West Africa, East Africa and the Horn of Africa (Calow et al., 2009). In periods of prolonged drought, pipeborn systems easily breakdown, borehole water levels and quality reduce rapidly, "surface water and shallow unimproved groundwater sources (shallow wells and small springs) often fail, leaving only water points abstracting from larger groundwater bodies operational. Therefore, often only the larger springs, deep hand-dug-wells or boreholes are reliable across seasons and in drought periods" (Macdonald, 2009:7- 8). Nevertheless, in poor aquifers, an upsurge in demand for water, particularly during excessive dry seasons, can result in increased drawdowns, and consequently an increased unpredictability and risk of failure of water sources. As demand for water continues to rise as rural population soars, the net effect includes reduction in quality and availability of water resources. Besides, increased economic activities could result in water pollution, deteriorate the quality of human health and cause damage to facilities used for transportation and delivery of drinking water to rural households. This affects the sustainability of water resources and increases the burden of water managers to satisfy the average annual rural population's demand for quality rural water.

2.1 Contribution to Knowledge

This study argues that the sustainability of rural water delivery projects may not always be best achieved by radicalisation and centralisation of development. Nonetheless, through participatory democracy, decentralisation can contribute to achieving a good ecologically sustainable water projects and locally self-governing society. Although centralisation might sometimes produce better water projects outcomes particularly at the national and international levels, this study postulates that if the medium to long-term aim is to promote ecologically responsible citizenship and eco-self-governing rural communities with dispositions most likely to be conducive to sustainability of water and local development projects, then effective decentralisation, community management and depoliticisation of water projects should perhaps make this more likely. As with democratisation, decentralisation is not just about getting the right outcomes now; it is also concerned with fostering a good society inhabited by ecologically concerned and participatory citizens. Therefore, in formulating the knowledge perspective for studying the connection between community drinking water projects and sustainability of development locally, the decentralisation and participatory democrats approaches provided useful prototypes and critical ecological imperatives. This article adopts these traditional political approaches to effectively respond to the ecological challenge of achieving a balanced synthesis of human ecology with the principles of (social, economic, political) change and behavioural modifications for sustainable and self-governing society. This unified outlook enabled this study to approach the explanation of local development in terms of a continuous (reciprocal) interaction between economic, social, political, behavioural and environmental influences on portable water sustainability at the lowest level (micro) of governance. This way, the study chronicled measures and offered critical ecological imperatives which contributes to governmental policy, the current sustainability discourses and understanding on the complexities and dynamisms involved in the sustainability of communities drinking water and local development projects, with reference to Ghana as a developmental state.

3. Data and methodology

3.1 Epistemology and design

This rural ecologically-driven study employed the post-positivist epistemology and cross-sectional survey design (Babbie (2001) to examine the factors influencing the sustainability of rural communities drinking water and local development projects in the Savaanah area of Northern Ghana. The study philosophy and design enabled a systematic and objective evaluation of the hypothesis through a proportionate collection of data from representative sub-set of the target population cohorts through direct solicitation. The study utilised self-designed and semi-structured face-to-face interviews with predominantly illiterate rural households and questionnaires which were self-administered to literate officials. The instruments were administered to rural end-users of water and projects managers engaged in the rural water sector (McClosky, 1969). Drawing from Saunders, Lewis and Thornhill (2009), the data collected by the cross-sectional design was utilised to predict relationships between the independent and dependent variables.

3.2 Study population and sampling approach

The study population constituted a sample frame of disadvantaged rural household population (units for analysis) of 19,646, composed of Bole (7,765), Central Gonja-Buipe (8,905) and West Gonja-Damongo (2,976) districts, which was obtained from the three local District Assemblies where the study was conducted (Ghana Statistical Service, 2014). The sample frame composed of the population or the universe of specific interest, the sum of the subjects and the specific environment or case areas of interest to the researcher Kothari (2004). Purposive sampling technique (Babbie, 2016) was used to select the Savannah region and the case study areas based on common demographic characteristics. The probability sampling approaches, involving the proportionate, systematic and simple random techniques were used to sample 450 adults (aged 18-50+), composed of 392 rural household heads and 58 officials from water related institutions. At the institutional level, the sample frame (68) was theoretically determined, however, the units of analysis were determined through the proportional and simple random sampling (Attewell and Rule, 1991). The study targeted all the officials who worked directly with water projects within the three pre-selected districts (Bole, Damongo, Buipe) of the Savannah region. The disaggregated target staff data across the institutions were: World Vision-Ghana (10 employees), CWSA (20 employees), MWRWH (3 employees), traditional rulers (5 people), District Assembly staff (10 employees), CSIR (5 employees), Water and Sanitation Committees (10 elected members) and Water and Sanitation Management Teams (5 elected members). The study population and sample size were reasonably large enough to permit representativeness, inference and generalisation (George and Mallery, 2003) of the study to the entire rural Savannah population.

3.3 Sample size determination and sampling procedures

The determination of sample size for each population cohort (households and officials) was based on the total study population and a statistical model established by Miller and Brewer (2003) (Equation 01a); $\{n=N/\ [1+N\ (\alpha)\ ^2]\}$, where, n= sample size, N = sampling frame (19,646), α= error margin, set at (0.05) and 1= constant value, hence $n=19{,}646/[1+19{,}646\ (0.05)^2]$, $n = 392.02$ households. The units for household analysis were determined across each of the districts and the pre-selected institutions based on a population proportional formula (Equation 02a) = {P x n/N; where P = proportion of each district's population strata, n = sample size and N = total district population}. The selection of household heads was undertaken through the systematic random sampling technique (Sarantakos, 2013), statistically expressed as (Equation 03) = {Kth = N/n}, where N= sample frame or total rural population (19,646) and n= sample size (392), hence, Kth =19,646/392, therefore, Kth = 50. The procedure for systematic selection was determined through a sample interval (1-50th), after which every 50th household was selected, and the head was approached for interview. Similarly, samples for officials were statistically determined following the model of Miller and Brewer (2003) (Equation 01b): $n=N/\ [1+N\ (\alpha)\ ^2]$, where, n= sample size, N = sampling frame (68), α= error margin, set at (0.05) and 1= constant value, therefore, $n = 68/[1+68\ (0.05)^2]$, n =58.12. Meanwhile, the total number for officials selected from each institution was based on a sample proportional formula (Equation 02b) = (P x n/N; where P = proportion of each institution's population strata, n = sample size and N = total sample frame of officials), however, the units for analysis were selected using the simple random sampling (with replacement) approach (Mugenda, 2003), been oblivious of employee turnover and possible effects on the study. Following Litwin (1995) proposition, the simple random approach utilised the lottery method, which ensured all eligible respondents were listed and randomly hand-picked to determine their participation in the study.

3.4 Scales and measurement of research variables

The study measured variables for dependent, independent, moderating and controlled with series of questions relevant for each variable based on widely acceptable measurements for primary data. The independent variables (Xs') and dependent variable (Y) were measured on nine items of questions which covered the number of times respondents were physically present at accountability meetings, participated at meetings, provided financial and communal labour support, compliant with pollution control, projects training/education programmes, compliant with maintenance and in the districts water projects decision making processes. The variables were measured on a time-scale (numbered 0-10), indicating the rate/ number of times meetings were held and number of times respondents participated in projects sustainability meetings. Drawing from Pallant (2003), a time-scale measured the number of times participants were allowed or their views were taken by a decision making process or events on water sustainability at the local level. Consistent with George and Mallery (2003), a high numerical score/response by a respondent indicated a high level of compliance and participation at meetings while a low numerical score/response indicated a none or low degree of the respondent's participatory level and contribution to sustainability of water projects. The study expected that the independent variables or sustainability factors would influence continuity of water projects at the lowest level of development.

3.5 Quality assurance, ethical considerations and reliability of data

A small scale pilot study was conducted at Savelgulu District, a neighbouring district which shared similar socio-demographic and ecological structure with the study districts. This enabled a pre-test of about 45 (10%) of the instruments for quality assurance (Mugenda, 2003), through reliability, consistency and construct validity testing. Based on Pallant (2003) and George and Mallery (2003) propositions, a correlation coefficient (Cronbach Alpha) greater or equal to 0.7, was considered acceptable compared with best practices and standards for reliability test. Appropriate research ethical clearance was obtained from both the Research Ethics Committee (REC) of the University of Johannesburg (UJ) and local institutions in Ghana where the study was conducted.

Meanwhile, research ethics and survey technical standards (Sarantakos, 2005) were observed throughout the study. The respondent's anonymisation, voluntary participation (Babbie,2016), consent, withdrawal, data protection/ securitisation and data utilisation protocols (Litwin, 1995) were assured, before, during and after the data collection. A pilot study was undertaken which enabled the study pre-test the instruments at Savelugu district, for construct validation and reliability. The reliability test (ie Cronbach Alpha) results for the predictors were as follows; X1 ($\alpha = 0.736$, $n = 45$), X2 ($\alpha = 0.817$, $n = 45$), X3 ($\alpha = 0.876$, $n = 45$), X4 ($\alpha = 0.798$, $n = 45$), X5($\alpha = 0.785$, $n = 45$), X6 ($\alpha = 0.962$, $n = 45$), X7 ($\alpha = 0.752$, $n = 45$), and X8 ($\alpha = 0.854$, $n = 45$). Compared with Pallant (2003) and Gliem and Gliem (2003) the Cronbach Alpha results for this study were confirmation of the reliability, reproducibility and consistency of the instruments for a large scale study and for testing relationships between the independent and dependent variables.

3.6 Data collection and analysis

Field data collection occurred with the support of 10 Assistants and 3 supervisors, recruited from the districts and trained on data administration and community entry techniques. The data collected from the three districts were combined, edited, cleaned and coded for both descriptive and inferential analysis, using the Statistical Package for Social Sciences (vrs 16). With 95% confidence level, and error margin of (0.05), inferential statistics (correlation, ANOVA and multiple regressions) were generated to determine relationships, tests statistical significance and the effect size of the independent variables on the sustainability of rural drinking water and sanitation development projects in the three districts. The multiple regression estimated the model; $Y = \beta0 + \beta1X1+ \beta2X2 + \beta3X3+ \beta4X4+ \beta5X5+ \beta6X6 + \beta7X7 + \beta8X8+ \beta9X9 + e$, where Y = dependent variable (water sustainability); β0= Constant (Y-intercept), β1, β2, β3, β4, β5, β6, β7, β8, β9 = unstandardized coefficients or slope of the predictors {X-variables; X1=community participation, X2= financial capacity, X3=community sense of ownership, X4=labour support, X5=education and training of community members, X6=suitable water technology, X7=periodic maintenance and rehabilitation of facilities, X8 = water pollution, X9=accountability/transparency} and e = error term.

4. Result and discussion

4.1 Baseline characteristics

The sample consisted of 450 adults, (32% females and 68% males) made of household heads and officials. Ages ranged from 18 to 50+ years. The districts had youthful population structure as most respondents 377 (83.8%) were between 18-49 years. An indication that water and development issues resonated more with the most energetic, economically active and productive population than the aged. A significantly higher percentage of the respondents were married (77%) and lived at Central Gonja-Buipe (42%) and Bole (36%) districts than West Gonja-Damongo (15%) district. High illiteracy rates prevailed across the districts, with most respondents (57%) completing Junior High/middle school, (12%) primary, (18%) Senior High School and only (13%) with tertiary or some college degrees. Employment into the public and civil service remained as low as (33%) since most of the local people lacked relevant educational qualifications, skills and training they could not be absorbed into the public sector.

However, across gender, males (65%) with college degrees were more likely to be engaged in the public/civil service and farming than females (35%). Most of the respondents (67%) were employed in the informal sector, predominantly composed of farmers (26%), traders (27%) and artisans (14%). This implies, the economic structure of the districts is rural and agrarian, largely driven by relatively illiterate population, hence, demand and utilisation of water could significantly increase by the informal sector than the public and civil service sectors. The management of water facilities were in the hands of the CWSA and the District Assemblies. The findings contradict Schouten and Moriarty (2003) who placed emphasis on community management approach as the ultimate pathway to water projects management at the micro level of governance. The districts are predominantly agrarian and mostly utilised unorthodox farming practices which could likely introduce chemicals into water sources and degrade ecological systems in the communities. Water shortage or scarcity arising from limited facilities, technologies, leakages and climate variabilities could thus dwindle/halt local development activities and livelihoods of majority of the district's population. Most of the respondents (71.3%) were low monthly income earners, with incomes either below GHC 100 or between GHC 100 to GHC 500 monthly. Comparatively, males (62%) earned higher incomes (GHC1000-GHC2000) than females (38%) whose incomes were between GHC 100-5001. On average, most respondents (40%) had relatively smaller household sizes (1-5). Households (9.7%) with highest size/composition (17+) earned the least monthly incomes (GHC1500 and below) while households (5.4%) with relatively smaller composition (1-5), earned much higher incomes (GHC 15001+). Essentially, a higher income implies higher capacity and power to afford water, influence water allocation and projects decisions.

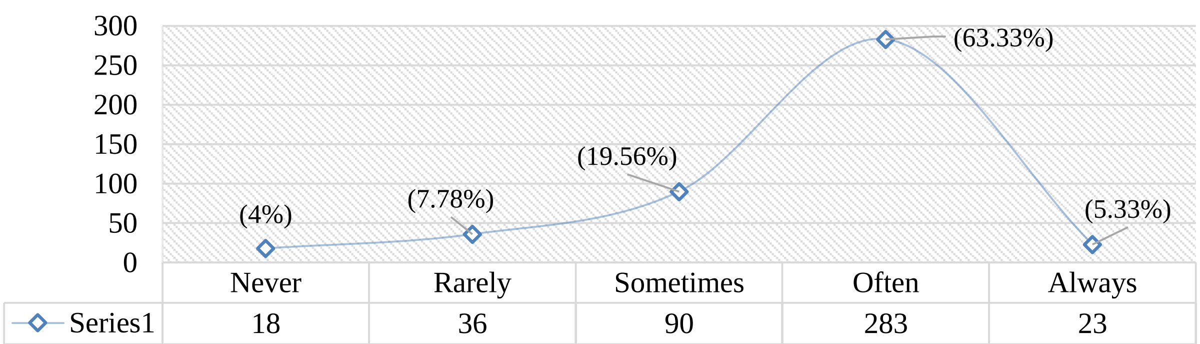
This was expected in a culturally diverse and multilinguistic communities which, however inordinate, project males as breadwinners at the basic unit of social organisation. Although hydrologically constrained, the districts had diversified sources of water, including pipeborn water, boreholes, dugout well, rain harvesting, sachet water and variety of naturally endowed surface water resources (rivers, Black Volta, White Volta lake, lagoons etc) which served as primary sources for the households. Water sources were utilised for either domestic (88%), consumptive (8%), commercial (2%) or recreational (2%) purposes. Approximately, (36%) of households in the districts rely on pipeborn water schemes for domestic chores (31.3%), consumption (4%) and commercial purposes (0.4%). Since pipeborn schemes were expensive (cost based on pay-as-you-fetch), none of the households used pipeborn water for recreational purposes. The most (51.1%) commonly used water sources in the districts were from boreholes, dugouts and rain water, while about (13.1%) relied on polluted surface water for all household related activities. Households with high composition and least incomes who were unable to afford the cost of pipeborn water and water from boreholes relied on unimproved surface water sources, albeit, the health hazards related to surface water consumption.

4.2 Frequency of water supply from districts drinking sources

The study interrogated the respondents on the frequency of water supply from their main drinking water sources in the communities to determine reliability and capacity of installed water facilities in the villages/settlements. In figure 1, the results showed that most 285 (63.33%) of the respondents often experienced irregular water supply from their main sources, 88 (19.56%) sometimes had water supply intercepted, 35 (7.78%) rarely experienced irregularities in water supply, 24 (5.33%) always had facilities supplying water while only 18 (4.0%) had uninterrupted water supply for a maximum period of twelve months. The findings meant that water facilities were performing below capacity and only minimally supplied the quantity of water required by the communities. This could be due to political infractions, geological, financial, technical or technological factors. The findings meant that the capacities and reliability of water sources at the rural levels were only perennial and intermittent (meaning, drinking water was not accessible throughout the year, particularly during the dry seasons, between October to March).

This is because the Savannah region is part of the most hydrologically constrained regions beside the Northern, Upper East and Upper West regions. Consequently, rural dwellers had to depend upon surface water supply, supplement with either privately management mechanized boreholes or dugout wells to meet shortfalls in household water demands. Similar to this study, Kinyanjui, et. al. (2016) discovered that drought accounted for the variation in the sustainability of rural water supply of the Nyahururu sub-county. Besides, the current study resonates with Sheffield and Wood (2008) who argued that droughts are becoming endemic in Africa and the extent of drought-affected areas are increasing. Meanwhile, Lencha (2013) and DWS (2015) perceived that funding and technology gaps have inverse effects on drinking water access in developing countries. This current study further discovered that those without sustainable access to basic and safely managed drinking water lived in rural slums, scattered and loosely populated areas which were difficult for traditional utilities to easily reach. Hence, albeit, drinking from unsafe water sources were public health risk exposure to rural dwellers, yet sometimes without any closest alternative options, the people are compelled to use these poor-quality water sources. The lack of access and intermittent social service delivery like water supply could further be attributed to the reduction in grant funding to the rural and sanitation sub-sector. This could probably be due to Ghana's attainment of lower-middle income status, which makes the country unattractive for development grants and interest free loans for highly non-profit and risk averse sectors including water.

Figure 1: Rate of Drinking Water Access from Main Sources (in the past 12 months)



N= 450; Source: Fieldwork (2019)

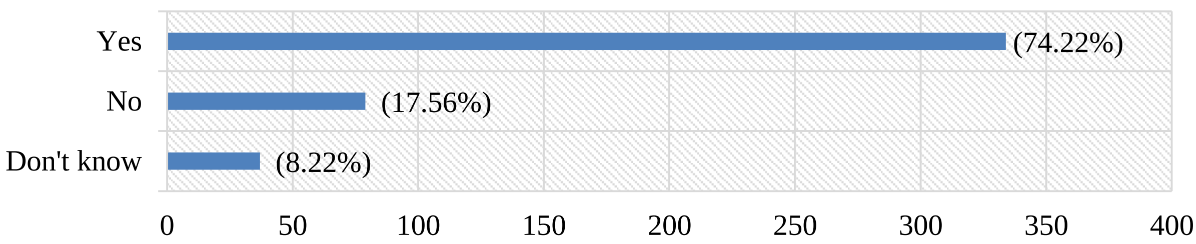
With persistent drought and perennial reduction rate of access to drinking water among rural dwellers, the goal of Ghana in achieving universal access to drinking water and sanitation would only remain an ambitious and well-articulated yet unmet goal even after 2030. Therefore, this study concludes that there is the need for durable actions, participatory and comprehensive ecological policy interventions to close rural water demand and supply gaps, enhance governance and sustainability of rural water resources. Similar studies have observed increase in water demand during droughts in Southern Africa (Calow et al., 1997), droughts in West Africa, East Africa and the Horn of Africa (Calow et al., 2009). Meanwhile, Macdonald (2009) also found that in periods of prolonged drought, pipeborn systems easily breakdown, borehole water levels and quality reduce rapidly, ultimately resulting in water scarcity, thus, compelling populations to revert to the use of polluted surface water sources.

4.3 Sustainability of drinking water systems/facilities in the communities

In Figure 2, most 334 (74. 22%) of the respondents confirmed that their water facilities were broken-down and had been abandoned for about twelve months without rehabilitation. Meanwhile, some 79 (17.56%) perceived their water facilities provided the optimal capacity of water required while 37 (8.22%) of the respondents did not know whether their water facilities were broken-down or functioning optimally. The possible elucidation for the low supply status and access to improved water and facility malfunctioning could be attributed to human-ecological relationships. The unbalanced exploitation and control over rural ecological resources adversely affects water distribution infrastructure and supply system, unstable rural electricity supply for mechanized boreholes, encroachment of water reserved areas, illegal small-scale mining activities “galamsey”, rapidly growing rural populations and incomparable rate of urbanisation among the communities.

Even though the communities were collectively responsible for effective operation and maintenance of their water facilities in the villages and small towns sub-sector, it appeared the responsibilities for water quality monitoring, rehabilitation, maintenance and replacement of outdated infrastructure were not well clarified to the immediate settlements where the facilities were sited. As a result, access to water, affordability and quality of drinking water continue to be predominant concerns, in both small towns and village settlements within the three districts

Figure 2: Water Facility Breakdown (Annually)



	Don't know	No	Yes
Series1	37	79	334

N= 450; Source: Fieldwork (2019)

The study found that about (68%) of the installed water facilities in the villages and small towns were either non-functional or functioning below the expected quality standards and required capacities annually. Meanwhile, it takes a long period (over 12 months) for such water facilities to be restored when they are broken down. The findings contradict earlier studies by the Manu (2015) and Development Work (2018) which found that a sustainable water source (piped/borehole scheme) should provide water for a minimum of 350 days in a year with less than 14 days of breakdown. Meanwhile, it reaffirms Macdonald (2009) who rather found prolonged drought, climate variabilities and ecological degradation as the causes of water facility breakdown.

The pattern for water supply showed that, approximately, 59 (15.0%) of the 392 household populations interviewed confirmed they had access to quality drinking water for at least seven days per week, 137 (35.0%) had three days of water access per week while the majority of the village dwellers 196 (50.0%) had no reliable access to quality drinking water and, therefore, have had to either rely on surface drinking water or travel long distances in order to fetch water. This indicates the CWSA and the DAs either lack of supervisory capacities, adequate data on functionality of water schemes and when water facilities were installed, or they lack the financial and technical capacities for immediate response in times of facility breakdown. This affects planning and strategy formulation for operation and maintenance (O&M), replacement and rehabilitation of water facilities which may have outlived their lifespan. Moreover, with limited funding capacities, the study discovered that the water supply technology in the settlements remain limited to dugout-wells, boreholes, limited mechanized pipeborn schemes. The findings confirm United Nations (2015), which predicts that unreliable access to water and sanitation adversely affect rural communities than cities, urban/peri urban communities. Moreover, it re-echoes Aharikundira et al., (2015) discovery that technology is required for improving water accessibility, infrastructure, purification, distribution efficiencies and disposal of waste in rural poor settlements of Kampala. Though there were self-help water supply initiatives and rain harvesting systems, yet they were limited in water supply and the most vulnerable/minority groups (Persons with Disabilities-PWDs) either had very little or absolutely no voice in decision making on planning for water supply delivery in the villages/settlements. The findings mean that even though deeply-rooted in ecological conservation, water is also inextricably knotted in socio-cultural, physiological and humanistic facets of life. Therefore, local communities and water consumers including vulnerable groups must be active participants in water allocation, water dialogue and decision-making processes. Moreover, there is the need to for CWSA and the DAs to pursue inclusive and participatory initiatives, discourses, policies and legislations grounded on the global mission of achieving effective community water governance and equitable water allocation, as precursors to sustainable development. The findings support the green ecologists and politico-ecological narratives which advocates for democratisation (Baffoe-Bonnie et. al., 2008), depoliticization (Wrong, 1979), public participation (Neil, 2007) and locally self-governing approaches (Roger & Hall, 2003) to the operation of rural water and sanitation facilities.

In Table 1, around two-thirds (78.23%) of all installed water facilities in Bole, Damongo and Buipe communities were either partially or completely broken down. The rate of malfunctioning of water facilities showed variations across the communities with Buipe (59.23%) mostly affected, followed by Bole (12.22%) and Damongo (6.78%) respectively. Though water facilities in Buipe areas appeared mostly affected, the findings showed that the villages/settlements in Buipe (5.76%) and Bole (6.44%) appeared to be putting much efforts towards improving/rehabilitating their water facilities than the villages/settlements in Damongo (1.78%). The findings showed that breakdown of water facilities was very common in the Savannah areas of northern Ghana. This indicated the existence of a poor culture of maintenance of drinking water facilities and that the local governance structure for water in the communities were weakened, possibly due to low/non-participation or lack of projects support by residents. Moreover, the findings implied that the support for water facilities in the area was provided possibly within project scheduled phases, however, post-construction assistances were either non-existent or truncated with the completion of implementation phase.

Table 1.

District location and functionality of water systems

Experienced facility breakdown (annually)	District Location			
	Buipe (%)	Damongo (%)	Bole (%)	Total (%)
Yes	59.23	6.78	12.22	78.23
No	5.76	1.78	6.44	13.98
I don't know	2.67	1.56	3.56	7.79
Total	67.66	10.12	22.22	100

N = 450; Source: Fieldwork (2019)

The findings revealed weak regulatory, financial capacities and commitment of the CSWA and the DAs in ensuring access to affordable and clean drinking water for rural people. None of these institutions are penalized for lack of access of water by rural dwellers. It further implied that the DAs and the CWSA, either did not have deliberate policies and mechanisms for maintenance and rehabilitation of facilities or if there were any at all, implementation of such post-construction sustainability schemes were ineffective across all the villages and towns in the communities. With a large proportion of water systems in a state of disrepair/malfunctioning, water scarcity and conflict over the few available schemes are eminent, prices of available schemes are likely to increase and low-income earning households (see Table 1) are most likely to revert to the use of unimproved (surface water), thus exposing them to waterborne diseases. The results reaffirm Morinville and Harris (2014) who discovered that in Ghana, O&M practices for rural water sources remain poor and many gravity flow schemes and point water sources are not fully operational. Moreover, it gives credence to DWS

(2015) contention that O&M is capital intensive, hence, the management and financial capacities for water expansion projects become a challenge to many local authorities.

Moreover, the travel distance to water sources are likely to increase with children most likely to miss school either due to water related sicknesses or the need to support their parents in fetching water for the household. In effect, the rural-urban rate of access to water is likely to widen, while power imbalances and rural-urban population drift could increase due to limited social amenities and this could ultimately shrink rural economies and livelihoods. Moreover, the results could be attributed to the nature of the Savanna ecological zone which is typographically noted for low underground water table and prolonged drought especially during the unset of the dry seasons. As a result, most water sources such as boreholes are capped, ponds and river sources turn to dry up frequently. The communities experience acute water shortages and residents' braces through thick showing crowds, queues and sacrifices their sleep and comfort to access water. This affect daily activities, as residents, especially women and children, had to walk for long distances to fetch water for both domestic and commercial activities. The findings vindicate Schouten and Moriarty (2003) who contends that maintenance and rehabilitation of water projects assures service quality over time, futurity and availability of water and intergenerational fairness among populations.

4.4 Rural economy and perceptions of water scarcity

From table 2, there were gender variations with respect to the perceived impact of water scarcity with more females (60.00%) mostly affected than their male (40.00%) counterparts. However, respondents aged between 29-39 years indicated they were most severely affected (67.0%) by non-availability of water in the communities followed by those aged between 18-28 years (20.0%), those aged 40-49 years (10.0%) and those above 50 years (3.0%). The demand for water is concentrated among the most youthful and population, however, water use turns to gradually decrease with age and reduction in social and economic activities. However, in terms of occupation and effects on water scarcity, farmers 117 (54.6%) and traders 119 (25.1%) appeared to be the most adversely affected than all the other occupational groupings.

Table 2.

Crosstab of gender and effect on water scarcity

	Water scarcity		
Gender	Yes (%)	No (%)	I don't know (%)
Male	40	0	0
Female	60	0	0
Total	100	0	0

N= 450; Source: Fieldwork (2019)

Most of the rural dwellers were peasant farmers and traders, for whom, access to water was essential for promoting agriculture, food security, hunger reduction and commercial activities in the Savannah ecological area. Geographically, the disaggregated data revealed no significant variations (Bole; 35%, Central Gonja-Buipe; 38%; West Gonja-Damongo; 27%) in the rates of water supply among the three studied districts. However, in terms of income and occupation, households with less incomes (GH₵100 & below) and those engaged in agriculture, artisanship, masonry (construction) and rural production sectors (80.0%) appeared to be relatively mostly affected by intermittent water access than government employees (public/civil servants – 20%) with relatively higher incomes (GH₵ 1500 & above). Besides, the availability of reliable data is essential for planning and budgeting to mitigate future water demands and ensure population increases is coterminous with water supply. However, this study found that there was lack of metering and data on rural water production and consumption by the CWSA and the DAs.

Since most of the water sources in the areas were not connected to households, the pay-as-you-fetch system was largely operational in the rural water sector. It means that households with relatively high membership and high per liter consumption patterns were invariably likely to be charged more for water consumption than those with less membership size and lowered consumption standards. Since water is a basic human need, large but impoverished households which cannot afford the afront fees for water are more likely to resort to other unimproved sources, oblivious of the health risks involved.

Therefore, the governments' policies on sanitation and "war of water linkage" ought to be effectively enforced and not remain a mere political rhetoric. Timely repair, commitment to routine maintenance exercises and rehabilitation of outdate amenities are to be prioritised, budgeted and financed. Meanwhile, adequately trained engineers and dedicated pipe leakage "hot lines" should be stationed in each community. The local residents require education and training on water management, securitization and domestic management of water at the household level while public sensitisation and awareness could be essential to ensure timely reportage and communication on water leakages to responsible authorities. The results appear to have vindicated Aharikundira et al. (2015) who discovered argue that technology, local financial contributions, appropriate projects budgeting, competent human resources and knowledge of local socio-economic conditions are essential for competitive market edge and sustainability of community-based water projects.

4.5 Factors affecting the sustainable operation of water systems in the districts

The effective operation and maintenance of rural water systems require integrated approaches to address myriad of cross-cutting issues affecting local authorities and communities. These interlinking issues include effective participation of rural people in water delivery, appropriate water technologies, development of technical capacities, financial resources, managerial and administrative competencies, transparency/accountability structures, enabling political and environmental context in which water is produced and distributed.

Having identified these sustainability indicators in the literature, this study evaluated the extent to which the indicators influenced the effective operation of rural water schemes in the rural settings. Drawing from Pallant (2005), the study initially checked to find out whether there was correlation between the identified sustainability indicators in the communities. The correlation test revealed a medium to relatively strong association between (X1) community participation ($r = 0.576$, p-value = 0.019, n= 450), (X2) financial capacity ($r = 0.517$, p-value = 0.006, n = 450), (X3) community sense of ownership ($r = 0.573$, p-value = 0.012, n = 450), (X4) labour support ($r = 0.474$, p-value = 0.015, n = 450), (X5) education and training of community members ($r = 0.469$, p-value = 0.021, n = 450), (X6) suitable water technology ($r = - 0.436$, p-value = 0.018, n = 450), (X7) periodic maintenance and rehabilitation of facilities ($r = -0.503$, p-value = 0.029, n = 450), (X8) frequent water pollution ($r = - 0.389$, p-value = 0.041, n=450), (X9) accountability/transparency ($r = - 0.250$, p-value = 0.15, n = 450) and sustainability of water facilities. The findings meant that where rural dwellers were recognised as equal partners, have strong politico-ecological voice and control over decision making on water allocation, there is an almost irresistible likelihood of sustained delivery of water services. Conversely, the docility, apathy and lack of control/power over decision making is likely to result in dysfunctionality of water facilities, water shortage and water crisis among the rural and small towns in the communities.

Similarly, the results showed that financial and labour contributions, control over pollution of water resources, capacity building, commitment to rehabilitation of outdated facilities and ensuring transparency and accountability of water allocation are likely to ensure continuity and sustainability of rural water systems in the communities. The results confirm Morinville & Harris (2014) argument that post-construction monitoring, and technical, funding and participatory gaps exist at the district and rural level, with the district water offices focusing more on construction and less on maintenance. Moreover, it validates Kinyanjui and Wanyoike (2016) study which found strong positive correlation between; financial capacity/water tariffs ($r = 0.759$, Sig. = 0.00, N=60), community participation ($r = 0.839$, Sig.= 0.053, N=60), project management capacity ($r = 0.658$, Sig.= 0.065, N=60), human resources ($r=0.754$, Sig.=0.037, N=60), facility. rehabilitation/maintenance/repairs ($r = 0.934$, Sig. = 0.00, N=60), pollution ($r = 0.898$, Sig.= 0.052, N = 60), technological capacity ($r = 0.769$, Sig.= 0.041, N=60) in Nyahururu sub-county of Kenya.

The correlation test results appear to have further affirmed Manu (2015) who found that the majority of rural water projects are not regularly maintained and hence at risk of regular breakdowns, meanwhile, political commitment in construction and maintenance of existing water supply schemes is demonstrated mostly during an election year. Besides, Addo (2010) and (Bohman, 2010) also found association between excessive interference by politicians in rural water policies (medium, short, long-term), lack of maintenance, transparency/accountability (arm-twisting projects selection and tariff setting for electoral fortunes) to have adversely affected sustainability of water and local development projects. Nonetheless, the findings contradict Marks et al. (2014) who found that households participation during meetings (p-value = 0.04; $\alpha < 0.01$; n=176), involvement in technical decisions (p-value = 0.6; $\alpha < 0.01$; n=176) and labour contribution to handpump construction (p-value = 0.07; $\alpha < 0.01$; n=176), were each strongly and positively associated with poorer handpump platform infrastructure in both regions. Having established the association between the variables, the standard multiple regression analysis was then utilised to predict factors which influenced the variabilities in the sustainability indicators.

The dependent variable (Y= sustainability of water facilities) was measured based on the annual (12 months) rate of breakdowns of drinking water supply and the set of factors considered as the independent variables/predictors (X) were: (X1) community participation, (X2) financial capacity, (X3) community sense of ownership, (X4) labour support, (X5) education and training of community members, (X6) suitable water technology, (X7) periodic maintenance and rehabilitation of facilities, (X8) water pollution and (X9) accountability/transparency. The regression analysis estimated the equation: $Y= \beta0 + \beta1X1+ \beta2X2 + \beta3X3+ \beta4X4+ \beta5X5+ \beta6X6 + \beta7X7 + \beta8X8+ \beta9X9 + e$. Therefore, in relating the regression equation to the study, it was deduced that: Y = dependent variable (water sustainability); β0= Constant (Y-intercept), β1, β2, β3, β4, β5, β6, β7, β8, β9 = unstandardized coefficients or slope of the predictors (X-variables) and e = error term. The regression model summary is presented in Table 3.

Table 3.

Multiple regression model on sustainability of water facilities in the districts

Regression Model Summary					
Model	R	R-Square (R^2)	Adjusted R-Square	Std. Error of the Estimate	p-value
1	0.835	0.697	0.556	0.281	0.013

a. *Predictors: (Constant), (X_1) community participation, (X_2) financial capacity, (X_3) community sense of ownership, (X_4) labour support, (X_5) education and training of community members, (X_6) suitable water technology, (X_7) periodic maintenance and rehabilitation of facilities, (X_8) frequent water pollution, (X_9) accountability/transparency, Note: N = 450; Source: Fieldwork (2019)*

From Table 3, the multiple regression value was (r = 0.835) which was obtained by squaring the root of "r^2", that is {r=√(r^2)=√0.697=0.835} The coefficient of determination (r^2 = 0.697) was obtained by squaring the multiple regression value "r", that is {r= r^(2)=〚0.835〛^2=0.697}. The coefficient of determination (r2) result meant that, about 69.7 percent of the variations in rural water sustainability {the dependent variable (Y)} were collectively explained by all the independent variables/predictors (X-variables). The findings implied that there were other unexplained rural water sustainability factors (30.3%) which should become a subject for further research investigation and statistical analysis. The regression model reached statistical significance with the p-value (0.013) less than the predicted alpha-value (0.05), that is {p-value = 0.013 < α = 0.05}. In Table 4, the results of the Analysis of Variance (ANOVA), indicated that the overall variations accounted for by the regression model had {F 3 with DF 74} = 3.4034, p < 0.05, α = 0.05. Therefore, since the p-value (0.017) was less than the alpha (α = 0.05), it provides sufficient evidence that the relationship between the dependent variable and the explanatory/predictor variables is statistically significant, indicating a confirmation of a regression relationship.

Table 4.

ANOVA (b) of Sustainability of rural communities water supply systems

Regression Model Summary					
Model 1	Sum of squares	DF	Mean square	F	Sig.(p-value)
Regression	1.7664	9	0.6588	3.4034	0.017
Residual	12.5786	74	0.3076		
Total	14.345	83			

b. Dependent Variable (Y): Sustainability of rural water. N = 450; Source: Fieldwork (2019)

Table 5.
Multiple Regression and Correlation Coefficients on Sustainability of the Districts Rural Water Facilities

Coefficients							
Model 1 Sustainability indicators	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig. (p-value)	Correlation coefficients (r)	Tolerance (X_1 to X_9)
(Constant)	0.898	0.511		1.758	0.003*		
Community participation	0.384	0.110	0.592	3.494	0.019*	0.576	0.684
Financial capacity	0.178	0.056	-0.545	3.180	0.006*	0.517	0.672
Community sense of ownership	0.009	0.082	0.507	0.112	0.012*	0.573	0.645
Labour support	0.023	0.062	-0.476	0.372	0.015*	0.474	0.613
Water technology	-0.256	0.096	-0.471	-2.657	0.018*	-0.436	0.643
Community education and training	0.143	0.055	0.456	2.577	0.021*	0.469	0.521
Rehabilitation/ maintenance /repairs	-0.248	0.095	-0.502	-2.617	0.029*	-0.503	0.605
Pollution of water sources	-0.032	0.042	-0.432	1.328	0.041*	-0.389	0.432
Accountability/transparency in water supply	-0.055	0.030	-0.124	-1.851	0.015	-0.250	0.330

Dependent variable (Y): Sustainability of water allocation measured by continued supply of HHs drinking water from main source. Note: *coefficients are statistically significant at 0.05 level, since p-value < 0.05.
Note: *"water project sustainability",* within the context of this study, is defined as the length of the useful life of water supply infrastructure. More specifically, it is the capacity of an improved water supply source such as boreholes, pipe scheme etc to provide continued beneficial potable water services over time (at least 12 months minimum).
N = 450. Source: Fieldwork (2019)

The study therefore concludes (based on Table 4) that the level of participation, financial capacity, sense of ownership, accountability/transparency, education and training, water technology, maintenance/rehabilitation of facilities, water pollution and labour support influence the sustainability of rural water supply schemes. To further establish the nature of the relationship between the dependent variable (y) i.e. sustainability of water supply and the predictors (X-variables), the correlation coefficient and the coefficient of determination were computed. While the correlation coefficient measured the strength of the relationship between water sustainability and the predictors (X-variables), the coefficient of determination (standardised beta values), measured the proportion of the total variations of water sustainability which were explained by each of the predictors (X-variables).

From Table 5, the results of the correlation coefficients (r), even though low, confirmed that there exists a relationship between rural water sustainability (Y) and the predictors (X-variables). The largest standardised beta values were (beta = 0.592), (beta = - 0.545), (beta = 0.507), (beta = - 0.476), (beta = - 0.471), (beta = 0.456) and (beta = - 0.502) which were for community participation, financial capacity, community sense of ownership, labour support by local people, suitable water technology, education/training for community members, periodic rehabilitation/ maintenance and repair of outdated facilities respectively. The positive standardised coefficient beta values revealed that, as the DAs and local authorities increased the participation of rural dwellers (beta = 0.592), educated and trained the community members (beta = 0.456) and promoted a sense of community ownership (betta= 0.507) for installed water facilities, the more likely the water supply would be sustained locally in the villages, towns and districts.

The results further revealed that community participation, education/training and community sense of ownership of their own water facilities made the strongest positive contributions to explaining the variability in the dependent variable (rural water sustainability), when the variances explained by all the other variables in the model were mutually controlled. Moreover, the coefficient for financial capacity (beta= - 0.545), periodic rehabilitation/ maintenance and repair of obsolete facilities (beta = - 0.502), labour support (beta = - 0.476), suitable water technology (beta = - 0.471), water pollution (beta = - 0.432) and accountability/transparency of water allocation (beta = - 0.124), contributed negatively in explaining the sustainability of water supply in the communities. The negative coefficient results suggested that, the less the financial capacities of the communities, the Assemblies and the CWSA and the more they relaxed in supervising and undertaking scheduled rehabilitation/maintenance and repair of obsolete water facilities, the more likely the capacity of the water infrastructure to provide reliable water supply to residents in the towns and villages.

Besides, the findings showed that as labour support of the rural dwellers reduces and their commitment to water pollution prevention diminishes, the less likely would become the reliability of water facilities in the districts. Similarly, the reduction in water technologies (suitable to rural settings) and relaxed accountability/transparency in the operation and management of the available water schemes would inversely reduce water supply in the communities. The coefficients for financial capacity (beta= - 0.545) and scheduled rehabilitation/ maintenance of obsolete facilities (beta = - 0.502), made the strongest negative contributions to explaining the variability of water sustainability when all the other predictors (X-variables) were mutually controlled. The tolerance values of the collinearity diagnostics were also measured. Pallant (2005) suggests that, if the tolerance value in a multiple regression is small, that is (less than 0.10), it indicates that the multiple correlation with other predictors is high, suggesting the possibility of multicollinearity. In this study, the tolerance values of the predictors (X-variables) were; X1= 0.684, X2= 0. 672, X3= 0. 645, X4= 0.613, X5= 0.643, X6= 0.521 and X7= 0.605, X8 = 0. 432 and X9= 0. 330. Since the tolerance values/results were not less than Pallants' (2005) cut-off point of 0.10, the study did not violate the principle of multicollinearity. Therefore, the study proceeded to evaluate the regression model and test the null hypothesis (H04) which presumed there were no statistically significant associations between the independent (Xs') and the dependent variables (Y).

4.6 Regression equation and hypothesis (H_0) test results

From table 5, the unstandardized values were used to estimate the regression equation: $Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \beta 8X8 + \beta 9X9 + e$. where; $\beta 0 = 0.898$, $\beta 1X1 = 0.384$, $\beta 2X2 = 0.178$, $\beta 3X3 = 0.009$, $\beta 4X4 = 0.023$, $\beta 5X5 = - 0.256$, $\beta 6X6 = 0.143$, $\beta 7X7 = - 0.248$, $\beta 8X8 = - 0.032$, $\beta 9X9 = - 0.055$ and $e = 0.05$. Therefore, the relationship between rural water sustainability and the predictors (X-variables) was stated as: $Y = 0.898 + 0.384 (X1) + 0.178 (X2) + 0.009 (X3) + 0.023 (X4) - 0.256 (X5) + 0.143 (X6) - 0.248 (X7) - 0.032 (X8) - 0.055 (X9) + 0.05 (e)$. The study concluded from the regression equation that rural water technology, rehabilitation of facilities, water pollution, commitment to accountability/transparency of water supply were negatively/inversely associated with sustainability of water facilities in the villages and rural areas in the districts. The equation meant that as rural water technology decreased - 0.256(X5), scheduled rehabilitation of facilities are missed/reduced - 0.248(X7), relaxed control of water pollution - 0.032

(X8), transparency and accountability of water distribution reduced - 0.055 (X9), so does the reliability and capacity of water facilities to provide quality drinking water to rural dwellers in the districts.

On the other hand, community participation 0.178 (X1), financial capacity 0.178 (X2), community sense of ownership of facilities 0.009 (X3), labour support by local people 0.023 (X4) and education/training of community members were positively related with sustainability and reliability of rural water schemes. This meant that the contribution of local citizens in a democratic, decentralised and community-based water governance system was found to positively affect the sustainability of water supply services. In effect, it implied that, in order for water schemes to ensure sustainable water provision, they have to be demand-driven where the local people are placed at the centre of participating in decision-making, owning and managing their water supply systems, ensuring cost recovery and engaging in activities of maintaining and rehabilitating their water facilities post-construction. This is because local people turn to know services which work best for them.

To achieve this, the study further found that corresponding financial capacity, labour support, training in the form of local capacity building (ie education and training), with broader consultation and engagement of relevant stakeholders, must remain top priorities in order to achieve sustainable community water supply. Having developed and interpreted the regression equation, the study now estimated the hypothesis (Ho) which stated that: "there is no statistically significant relationship between participation, financial capacity, periodic accountability/transparency, technological capacity, periodic maintenance/rehabilitation, water pollution, education and training, labour support, communities' sense of ownership and the sustainable functionality of rural communities drinking water projects". In testing for the null hypothesis (H0), the decision rule applied was; where the significance value was greater than (>) the predetermined significance level {that is, where p-value > alpha value (α)= 0.05}, then the study accepted the hypothesis, however, where the observed effect size was statistically significant {that is, p-value ≤ alpha value (α)= 0.05}, the hypothesis was ruled out, meaning the alternative hypothesis remained valid.

Therefore, from Table 5, since the correlation coefficients ie p-values for (X1) community participation (p-value = 0.019), (X2) financial capacity (p-value = 0.006), (X3) community sense of ownership (p-value = 0.012), (X4) labour support (p-value = 0.015), (X5) education and training of community members (p-value = 0.021), (X6) suitable water technology (p-value = 0.018), (X7) periodic maintenance and rehabilitation of facilities (p-value = 0.029), (X8) frequent water pollution (p-value =0.041) and (X9) accountability/transparency (p-value = 0.015), were found to be less than the accepted alpha (0.05), it meant that, these variables made statistically significant contributions to the prediction of the rural water sustainability (Y-dependent variable), and therefore, based on the decision rule, the study proceeded to rule out the null hypothesis (H0) and accepted the alternative hypothesis (HA). In effect, therefore, the findings indicate that lack of logistics and financial constraints turn to obstruct speedy monitoring and supervisory responsibilities of the CWSA and the districts. The DAs and CWSA, could be legally well structured and professionally staffed at the regional level, yet where they lack adequate operational logistics including vehicles, adequate field technicians, laboratories and adequate chemicals for water quality testing, it could affect their capacity for timely supervision, maintenance and rehabilitation of breakdown boreholes and mechanised community-based pipeborn schemes. This has adverse effect on water safety as delivery standards could easily be compromised by communities or private individuals who initiate and construct their own mechanised water delivery systems.

Similarly, in the sanitation sector, social, financial, technical and human capital are active preconditions for sustainable rural economies by linking sanitation service providers, rural dwellers and the private sector for integrated and inclusive development. In effect, this in turn could leverage adequate investments for O&M of outdated sanitation and water systems which have been discovered by this study to be one of the primary factors accounting for breakdown and malfunctioning of water facilities in the rural areas.

Theoretically, the regression model and the test results seem to validate the green theory (Neil, 2007) and democrats' perspectives (Wrong, 1979) on ecological sustainability which are premised on community participation (Baffoe-Bonnie et. al., 2008), good governance, training/education and empowerment of local communities (Roger & Hall, 2003). Moreover, in a similar multiple regression analysis Kinyanjui et al., (2016) discovered that {r=0.7654(a), r2 (r-square)= 0.586, adjusted r-square= 0.530, and std. error of the estimate = 0.3868}, which meant that six of the predictors/independent variables explained approximately (56.6%) of the variation in the sustainability of rural water supply of the Nyahururu sub-county. The results of the hypothesis test of this study confirmed Kinynajui et al. (2016) who observed in their study that since the variability in the Analysis of Variance (ANOVA) had {f-statistic = 2.7034, with sig. = 0.05, α = 0.05}, the study concluded the existence of regression relationship with statistically significant associations between the predictor variables and the predictors (dependent variables).

5. Conclusions

The study concludes that an educated, trained and well- informed population is relevant for promoting ecologically friendly attitudes and adopting lifestyles towards water conservation and livelihood activities within the local communities. This is because, an ill-informed, illiterate and predominantly untrained population could invariable affect water quality and quantities required for human consumption and productive activities in the study districts. Water was intrinsically part of the social, productive and economic life of the people. Scarcity of water would, therefore, likely to affect the everyday life, health, growth and development of residents in the districts. Breakdown of facilities and lack of maintenance were common among the districts, albeit, water had an inverse effect on promoting growth, occupations and economic activities in the communities as it had anthropogenic consequence on all facets of society and inextricably linked to human biological life. It constituted an essential life-support resource for consumption, recreation, domestic chores, trade and commercial life of the people including housing (building, construction and determination of rents), agricultural production, traditional and customary life of the local people in the districts.

Meanwhile, at all levels of water management (production, distribution, storage, consumption, reuse of waste water etc), inefficiencies, inept bureaucracy and political influences turned to prevail, and this had adversely dire consequences on capacities (funding, human resources, technologies, logistics etc) required for sustainability of water supply at the lowest (micro) level of development. A reduction in water allocation therefore implies a reduction in supply, which inexorably could result in competition, conflict over water and ultimately, reduce the life quality and livelihood standards of local people in the area. Water scarcity loomed, and as population and human activities increases with prolonged perennial droughts in the Savannah area, future demand for water is likely to exceed supply. If uncontrolled, this could exacerbate the use of polluted surface water, increase protestation, tensions and possible occurrence of water conflicts among communities.

Inferably, the practice of uncontrolled human population growth has the capacity to disrupt human ecology, affect water access and consumption patterns, especially in a lower-middle income country like Ghana. Measures for water conservation are therefore no longer indisputable but must be highly prioritised and depoliticised to ensure human-water continuum and water projects sustainability. Poverty, human insecurity, retardation, ill-health and mortality across all ages could prevail in communities without access to basic water. The communities are predominantly agrarian and mostly utilised unorthodox farming practices which could likely introduce chemicals into water sources and degrade ecological systems in the districts. Moreover, a polluted ground or surface water could increase the cost of local water purification, logistics /technologies and water tariffs beyond the already marginalised and peripheral households with low income earning opportunities.

6. Policy implications and recommendations

In the national pursuit for economic progress and anthropogenic development, efforts must be made to ensure human development and growth is in tandem with ecological equilibrium, with policy emphasis on ecological conservation, ensuring the futurity (posterity) of generations and rights of access to water are not compromised. Since human species flourishes with the availability and access to water, policies, legislative frameworks and local development initiatives must be eco-friendly and tailored to suite local constraints and conditions. As illustrated by this study, a participatory, decentralised and democratic oriented approach could be pivotal to obtain dependable inputs from end-users and the local people who exert excessive demand for water and sanitation.

Communities would require measures (short, medium to long-term) for ecological adaptation, pollution control and conservation of surface water, ground water and piped schemes. Conservation strategies and policies including the use of overhead polytan, underground water reservoirs must be promoted locally and cost-effective technologies for purification and domestic reuse of waste water should be harnessed. Moreover, green approaches and eco-friendly technologies must be highly prioritised by government and development actors including the local communities, the District Assemblies, CWSA, PURC and Environmental Protection Agency (EPA) in collaboration with traditional authorities and the private sector. Meanwhile, education, training and promotional measures must be developed by civil society actors, and legislations on water must be enforced at the districts level to promote ecologically self-conscious local people with enabled capacities, appropriate attitudes and moral obligations towards their environments and natural endowments including drinking water resources.

A locally self-governing, eco-friendly development and sustainability of water inexorably require that the government policies on sanitation and "war of water linkages" ought to be effectively enforced and not remain a mere window dressing nor political rhetoric. Timely repair, commitment to routine maintenance exercises and rehabilitation of outdate amenities are to be locally prioritised, budgeted and financed by the Assemblies, CWSA and the local people. Meanwhile, adequately trained engineers, dedicated pipe breakdown and leakage "hot lines" should be stationed at each district. Moreover, the local residents require education and training on water management, securitisation and domestic management of water at the household level while public sensitisation and awareness could be essential to ensure timely reportage and communication on water leakages to responsible authorities.

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