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WHAT MATTERS MOST? STAKEHOLDERS' PERCEPTIONS OF RIVER WATER QUALITY

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Abstract

The need to integrate stakeholders' views into environmental policy is increasingly gaining attention because this offers the opportunity to design sustainable and synergistic environmental strategies. Understanding and integrating the views of resource users into policy design and implementation could help address the most important challenges, gain community support, enhance project ownership, and avoid policies being rejected by local people. As a result, research in environmental management has focused on stakeholders' perceptions of river water quality and how to integrate such views into policy. While existing studies offer insights into the different ways in which stakeholders evaluate river water quality and potential factors influencing judgements, they appear to be limited in a number of ways. First, most of these studies focus on developed countries and may have limited contextual relevance to the developing world. Moreover, past studies focus on segments of society such as farmers and mainly on wastewater for agriculture. These shortcomings may limit our understanding of the topic and our ability to design effective policies to address water quality problems. Drawing on survey data from the Wenchi municipality in Ghana, we examine public perceptions of what constitute important measures of river water quality as well as factors influencing such judgements. Results suggest that while variables such as taste, colour, smell and litter are important, the presence of faecal matter in and/or around the river was rated the most important measure of river water quality while depth of river was the least important. Results further suggest that education, age, number of years a person had lived in a community, depth of river and the presence of aquatic vegetation influence water quality judgements. The findings of this research provide insights into what policymakers and regulators need to consider when attempting to influence behaviours in relation to water resources. We note, however, that while public perceptions of river water quality could guide water management policies, scientific measurements of water quality must not be replaced with stakeholder perceptions. This is because aspects such as ecological integrity may not be important to segments of the public but are an important aspect of water management. This is reinforced in the present study as there seems to be a lack of concern among the participants regarding river depth – an important factor for habitat provision and pollution dilution.

Keywords: Organoleptic Properties; Quality Perception; River Pollution; Water Quality Indicators; Ghana; Wenchi Municipality.

1. INTRODUCTION

The need to integrate stakeholders' views into environmental policy and management is increasingly gaining attention due to the numerous benefits of stakeholder participation (e.g., Bohnet, 2015). First, communities are diverse and may have different value systems, norms, circumstances and knowledge bases that affect human behaviour and are useful in shaping environmental management strategies (Raymond et al., 2010). Understanding the uniqueness of different communities and stakeholders is therefore helpful in addressing the complexity of water resource governance (Stringer et al., 2009). Local people, who are also the primary users of water resources, may have a better understanding of the socio-ecological context within which water resources are located. Engaging local people in the decision-making process empowers them to influence water governance processes (Withanachchi et al., 2018). This could increase their sense of ownership and the likelihood that people would support initiatives aimed at sustaining water resources as they ascribe to themselves the responsibility for water protection. In sum, understanding and integrating the views of resource users into policy design and implementation could help address the most important challenges, gain community support, enhance project ownership, and avoid policies being rejected by local people (Thomson, 1977; Ostrom, 1999; Ostrom et al., 1999; Okumah et al., 2020a).

These benefits of stakeholder participation have contributed to recent studies in environmental management focusing on stakeholders' perceptions of water quality and how to effectively integrate such views into policy design and implementation (e.g., Bohnet, 2015). Some studies have reported that stakeholders' perceptions reflect scientifically measured parameters of water quality (Jeon et al., 2005; Steinwender et al., 2008) therefore, where scientifically measured information on water quality is lacking, stakeholders' views can be a valuable source of data (Bohnet, 2015). Furthermore, it may be easier, cost-efficient and convenient to obtain subjective data on water quality than measures that rely on biophysical and chemical scientific assessments (Artell et al., 2013). We note, however, that subjective assessment of water quality hinges on beliefs, cognition and experience and therefore is likely to result in distortion of what appears to be the reality on the ground (Muckler and Seven, 1992). These value judgements, which are often based on experiences, may result in biased evaluation of water quality and sometimes contribute to errors in water quality judgements. Moreover, aspects such as ecological integrity may not be important to segments of the public but are an important aspect of water management. Despite these potential limitations of subjective assessments of water quality, perceptions of river water quality could complement scientific measurements of water quality to support water management policies.

The limited studies exploring perceptions of river water quality report that people evaluate the quality of water using its organoleptic properties. For instance, properties such as the taste, smell, colour and clarity (or transparency) of water are considered important measures of water quality among people who use the resource for recreational purposes (Smith et al., 1995; Steinwender et al., 2008; Cottet et al., 2013). Similar attributes may be used to judge the quality of water used for cooking, drinking and other household and commercial activities (Al-Khalidi, 2008; Nauges and Van Den Berg, 2009). Additionally, the presence of litter in water resources and the sanitary conditions of the riverbank may influence judgements (Cottet et al., 2013). Studies exploring factors that affect perceptions of water quality have found that geo-spatial factors (e.g., McDaniels et al., 1996; Bickerstaff, 2004; Brody et al., 2004; Withanachchi et al., 2018), socio-cultural factors (e.g., Pidgeon, 1998; Williams et al., 1999; Artell et al., 2013; Berry et al., 2018), socio-demographic factors (e.g., Davidson and Freudenburg, 1996; Slovic, 1999; Hitchcock, 2001; Bickerstaff, 2004; Leiserowitz, 2006) and personal experiences (e.g., Barnett and Breakwell, 2001; Dogaru et al., 2009) may influence perceptions of water quality.

While these studies offer useful insights into the different ways in which stakeholders evaluate water quality and potential factors influencing such judgements, they may be limited in a number of ways. First, most of these studies focus on developed countries e.g., United States (Anadu and Harding, 2000; Jones et al., 2018) and Denmark (Gachango et al., 2015), and may therefore have limited contextual relevance to the developing world. Extrapolating results from different socio-cultural, economic and climatic regions may lead to greater uncertainty in the usefulness of interventions designed to trigger changes in perceptions and behaviours related to water pollution and management (Deasy et al., 2010, Okumah et al., 2019a; Okumah and Ankomah-Hackman, 2020), thus, highlighting the need for research within the developing country context. Additionally, while it is useful to identify the different measures of water quality and perceptions of water pollution, it is important to know which factors are relevant to stakeholders. This helps to identify which measures to emphasise in water policy design and implementation, and aids in preventing costly conservation mistakes (Carwardine et al., 2008). Second, knowledge of what matters to stakeholders may help to intensify efforts to change perceptions where necessary. However, the limited studies in developing countries have rarely focused on exploring these issues. Moreover, past empirical studies in developing countries focus on some segments of society such as farmers and mainly on wastewater for agriculture (e.g., Ndunda and Mungatana, 2013; Gachango et al., 2015; Amponsah et al., 2016; Mayilla et al., 2017; Woldetsadik et al., 2018). Given that the broader population contributes to and is affected by river pollution and water management policies, we would argue that a narrow focus on segments of the population may limit our understanding of the topic and our ability to design comprehensive, well targeted and effective policies to address the problem (Okumah et al., 2019a).

We contribute to addressing these knowledge gaps by investigating public perceptions of what constitutes important measures of river water quality as well as factors influencing such perceptions. Specifically, the research addresses the following questions using data from the Wenchi Municipality in Ghana:

1) Which factors do stakeholders perceive to be the most important measures of river water quality?
2) Do stakeholders' perceptions of what constitute important measures of river quality influence judgement on the quality of rivers?
3) Which other factors might influence stakeholders' views on the quality of rivers?

The remainder of the paper is structured as follows: section two provides an overview of factors that influence water quality perceptions. Section three focuses on the study area and the methodology applied in the research. In section four, results are presented and key findings discussed in section five. The final section highlights the concluding remarks of the study.

2. **FACTORS INFLUENCING WATER QUALITY PERCEPTIONS**

Water quality perceptions are critical, especially, in the case where water is used for domestic and drinking purposes (Sheat, 1992). Public perception on the quality of drinking water could determine whether people would use the river for productive purposes or show negative attitudes towards water resources. A considerable volume of research has therefore focused on exploring the underlying factors responsible for people's judgements of water quality.

De Franca Doria (2010) notes that water quality perception may be shaped by a number of factors, but prominent among these factors are organoleptic properties such as taste, colour and smell. Organoleptic factors that drive perception of water quality may be associated with health risks regarding the consumption of water. In essence, the taste, colour and smell of water resources to a large extent determines the purity or otherwise of water. For example, water that is discoloured and have pungent smell may be perceived as polluted and likely to have a detrimental health implication to consumers. As indicated by Levallois et al., (1999), health risks such as intoxication, cancer and intestinal worms are critical health-related issues that could influence people's perception of water quality. Taken together, organoleptic properties such as colour and clarity are important drivers of water quality perception, particularly, when water is used for domestic and recreational purposes (Smith and Davies-Colley, 1992). However, as found by Dinius (1981), the discoloration of rivers was considered not to be harmful when used for industrial purposes. Besides, there is inadequate evidence that protecting the clarity and colour of water resources will safeguard ecological values (Kirk, 1988). Moreover, it is important to note that there could be wide variations in the appearance of water pertaining to different geographical settings.

The sanitary conditions of water resources (e.g., rivers and streams) could also be potential drivers of water quality perceptions. Water resources that have clean and hygienic surroundings, devoid of any solid and liquid waste may be regarded as safe and fit for consumption and for other activities such as fishing and swimming (Okumah and Yeboah, 2019). However, water resources characterised by filth and waste (particularly from human activities) may be perceived as contaminated and are likely not to be used for productive activities. In this sense, it may be common to find people exhibiting negative environmental attitudes and behaviours in relation to such resources due to the perceived poor quality of the resource. For instance, segments of the public are more likely to discharge human and industrial waste into the rivers when they perceive such resources to be poor owing to their discoloured nature (Abraham et al., 2016).

A study by Syme and Williams (1993) reveals that water quality perceptions may be shaped by neighbourhood satisfaction, confidence in local and national authorities, competences on the part of water related agencies and the beliefs in human control of environmental issues (de Franca Doria, 2010). That is, the effectiveness of local water management structures and their level of competence and control are critical determinants of how water quality is perceived. Similarly, the extent of authorities' control and influence they exert on mitigating environmental pollution could potentially predict water quality perceptions. For instance, in areas where residents regard water and environmental management authorities as effective, there is the tendency towards positive perception of water quality. Conversely, where people regard environmental managers as ineffective and incompetent, water quality perceptions might be negative. Focussing on farmers, Johnson (2003) found that values about environmental problems, where farmers reside and their level of control over environmental issues may be potential drivers of water quality perceptions. In a context where people feel that water resources are not subject to pollution and their level of control over the resource are enormous in magnitude, water quality perceptions may be positive (see also Withanachchi et al., 2018).

House and Sangster (1991) also found that contextual conditions in some rivers and lakes (typically presence of aquatic creatures) could be good predictors of water quality perceptions, especially, on the part of farmers and fisher folks. This is because water resources with abundance of organisms and aquatic plants are regarded by farmers and fisher folks to be less polluted, nutrient-rich and more conducive for inhabitation. To these stakeholders, living creatures may abound in water resources due to minimal contamination of these water bodies, hence they feel that such water resources are 'full of life'. Therefore, segments of the public (e.g. farmers and fishermen) may perceive water resources with abundant aquatic creatures to be pure and safe, thus, instilling public confidence in such water resources.

Socio-demographic variables could be significantly correlated with water quality perceptions (e.g., Stevens, 1996; Parkin et al., 2001; Kraus et al., 1992). In relation to gender, some studies (e.g., Anadu and Harding, 2000; Johnson, 2003) have found that women express higher concerns about the quality of water resources and other risk factors than males. Women's expression of higher concern over environmental conditions may be attributable to the fact that a considerable amount of household and other domestic activities are carried out by women, who mostly rely on natural resources like water bodies and forest resources. As a result, they appear more sensitive about environmental resources, thus, shaping their water quality perceptions. However, some studies (see for e.g. Griffin and Dunwoody, 2000) have indicated that gender may not influence water quality perceptions. The authors note that in some jurisdictions, women and men have the same level of rights and opportunities, thus, values, perceptions and normative ideas between males and females may be less significant. In this regard, gender differences may not account for variations in water quality perceptions. The authors point to other factors such as differences in world views and trust in institutions as critical drivers of water quality perceptions. This is because, world views shape interpretation and socially constructed ideals about the environment (Martin-Ortega et al., 2017) and influences how people perceive water quality. Therefore, whether gender influences water quality perceptions or not, remains contested as the link between gender and water quality perceptions appears to be mediated and/or moderated by other contextual factors (Martin-Ortega et al., 2017; Okumah et al., 2020c; Okumah et al., 2020b).

Some studies have also identified age as a potential factor influencing water quality perceptions. For example, older people may have experienced the conditions of water resources for a longer period of time and hence they may be in a better position to be able to detect alterations in water quality over a relatively longer period of time. This broad range of experience might influence their water quality perceptions. Younger people, often less experienced may not have witnessed the changing state of water resources. Their little to no experience may affect their perceptions regarding water quality. However, just like gender, the link between age and perceptions of water quality appears to be complex, as this may be dependent on other variables. As indicated by Stevens (1996), age may interact with other organoleptic factors and may influence how water quality is perceived. This argument is supported by other studies (e.g., de Franca Doria, 2010) who argue that water quality perception is a product of the interplay of a complex set of interactions from diverse factors (de Franca Doria, 2010).

Education has been reported to have a strong statistical association with water quality perceptions (Grondin et al., 1995). Education may affect the 'meanings people read' into water quality, thus, suggesting that more educated persons are likely to have broader knowledge and appreciation of what constitute water contamination and may affect their perceptions of water quality (EORG, 2002).

Griffin and Dunwoody (2000) have highlighted that ethnic minorities do not seem to be concerned about water quality due to socio-economic factors (Williams and Florez, 2002) or to their residential settings (Griffin and Dunwoody, 2002). Cultural factors to a large extent shape the socially constructed beliefs and myths that influence the interpretation of the environment (Canter et al., 1992). These socially constructed norms might influence water quality and risk perceptions among distinct ethnic groups. Water may also represent a significant object in many religious practises. In the context of religion, the roles that water plays (e.g., ablution and baptism) may be defined in terms of purity and the purifying element (Doria, 1998; Gritti, 2001). These religious perspectives on the purifying roles of water may largely shape perceptions on water quality.

Culture, values, beliefs and practices of a given people may reflect their shared understanding and perceptions about natural resources (Weller, 2007). Cultural values and beliefs constitute essential elements that people use to appreciate and make judicious use of environmental resources (Nazarea, 1999). To this effect, understanding ethnoecological values of natural resources are critical given that people's values, opinions and practises shape perceptions towards water resources. Gelles (2000) suggests that the cultural and value meanings of water may be understood from spiritual and ritual significance of water. The implications of water to distinct cultural groups may be broadly influenced by the spiritual uses of water for purification (e.g., ablution, baptism) and the many sacred rituals (self-cleansing attributes) to which water resources could be put. These strong spiritual and ritual attachments to water resources represent the way people conceptualize water resources.

Back (1981) provides an account of water in the American context as symbolising recreation. To Back (1981), water resources provide a basis of sustenance, offer protection against harsh climatic conditions such as droughts and facilitates the development of new species of living creatures such as plants and animals. Similarly, to the Inuit, water resources may have a broader value and spiritual connotation (Back, 1981). To these people, water resources (e.g., sea and lakes) are dwelling places for the creator of the universe and more powerful spirits. As a result, the Inuit attach great reverence towards water resources as scared places of the God(s). This belief goes a long way to influence positive environmental attitudes towards water resource. In other cultures, the perfect understanding of water may be portrayed by the protection roles played by water resources. For example, among the Iroquois, streams, lakes and rivers were connected to strategic defence points to provide an escape route or reinforces their defence strategies. In the same vein, areas with few natural water sources were regarded as poor and as a result, did not warrant any fierce opposition or attack from the mightier and wealthier nations (Back, 1981). Wheat (1967) also provides an account of the sustenance, physical and spiritual wellbeing meanings of water. For example, as a way of healing people of their illnesses, beads, which represented the various diseases were tied together with the patient's hair and buried into a flowing water body. It is believed that the running water washes away the diseases and misfortunes and renews the spiritual wellbeing of people.

The above discussion highlights the complex nature of the factors that could potentially influence water quality perceptions. As Johnson (2003) notes, the effects of socio-demographic factors on water quality perceptions could be mediated by contextual factors. This argument is reinforced by Griffin and Dunwoody (2000) finding that, whereas there is the tendency to ascribe perceptions to demographic factors, there could be underlying factors such as differences in world views and trust in institutions. Three important things emerge from the studies discussed so far: first, the need to apply multivariate statistical techniques that makes it possible to determine whether the independent variable predicts the dependent variable, not whether they are just correlated or not. The complex nature in which different variables interact to influence water quality perceptions implies that correlations are not adequate to unpack the drivers of such water quality perceptions. Therefore, regressions could be complemented with qualitative techniques to help explore deep and rich data and provide further meanings and nuances to quantitative results. Second, contextual factors (such as socio-cultural circumstances) may interact with all the other factors to determine water quality perceptions, thus the need to explore perceptions in different contexts. This suggests the need to explore perceptions across different geo-climatic, socio-political and economic regions (including developing countries). Lastly, most of the existing studies have focused on segments of society (e.g., farmers). Given that different social groups have different experiences, beliefs and knowledge bases, generalising the views of some groups to the entire population could be misleading. Moreover, the broader population contributes to and is affected by river pollution and water management policies (Okumah et al., 2019a), therefore, it is important to explore the views of the general public.

3. STUDY AREA, MATERIALS AND METHODS

3.1 Study Area

The research was conducted in three rural communities namely, Droboso, Subinso and Asubingya under the Wenchi Municipality in the Bono Region of Ghana. The Wenchi Municipality is bounded to the South by Sunyani Municipality and to the North by Kintampo South District (Figure 1a and 1b). It also shares a common boundary with the Tain District to the West and Techiman Municipality to the East. It lies within latitudes 7^{o} 30' South and 7^{o} 15' North and longitudes 2^{o} 17' West and 1^{o} 55' East. In terms of land size, the Municipality covers 1,296.6 Square kilometres.

The Municipality is well drained with major rivers such as the Tain, Subin, Kyiridi, Trome and Yooyo. Majority of rural dwellers in the municipality depend on these water resources for spiritual, domestic and industrial activities (Wenchi Municipal Assembly, 2014; Okumah et al., 2020b). This has resulted in a strong interaction between humans and these water resources, with both positive and negative outcomes. As evidence suggests, the use of water resources depends on public perceptions of the quality of the resource (Okumah and Yeboah, 2019; Okumah et al., 2020a). Past studies from some developed countries have shown that where people use water for recreational purposes and domestic activities, properties such as the taste, smell, colour and clarity of water are important measures of water quality (e.g., Steinwender et al., 2008; Cottet et al., 2013). Given that the rural population in the Wenchi municipality depend on the water resources for a wide range of activities, it is important that we investigate the measures of water quality that matter to them. This will help to maximise the use of the resources and also enable policymakers and regulators sensitise the public, where necessary.

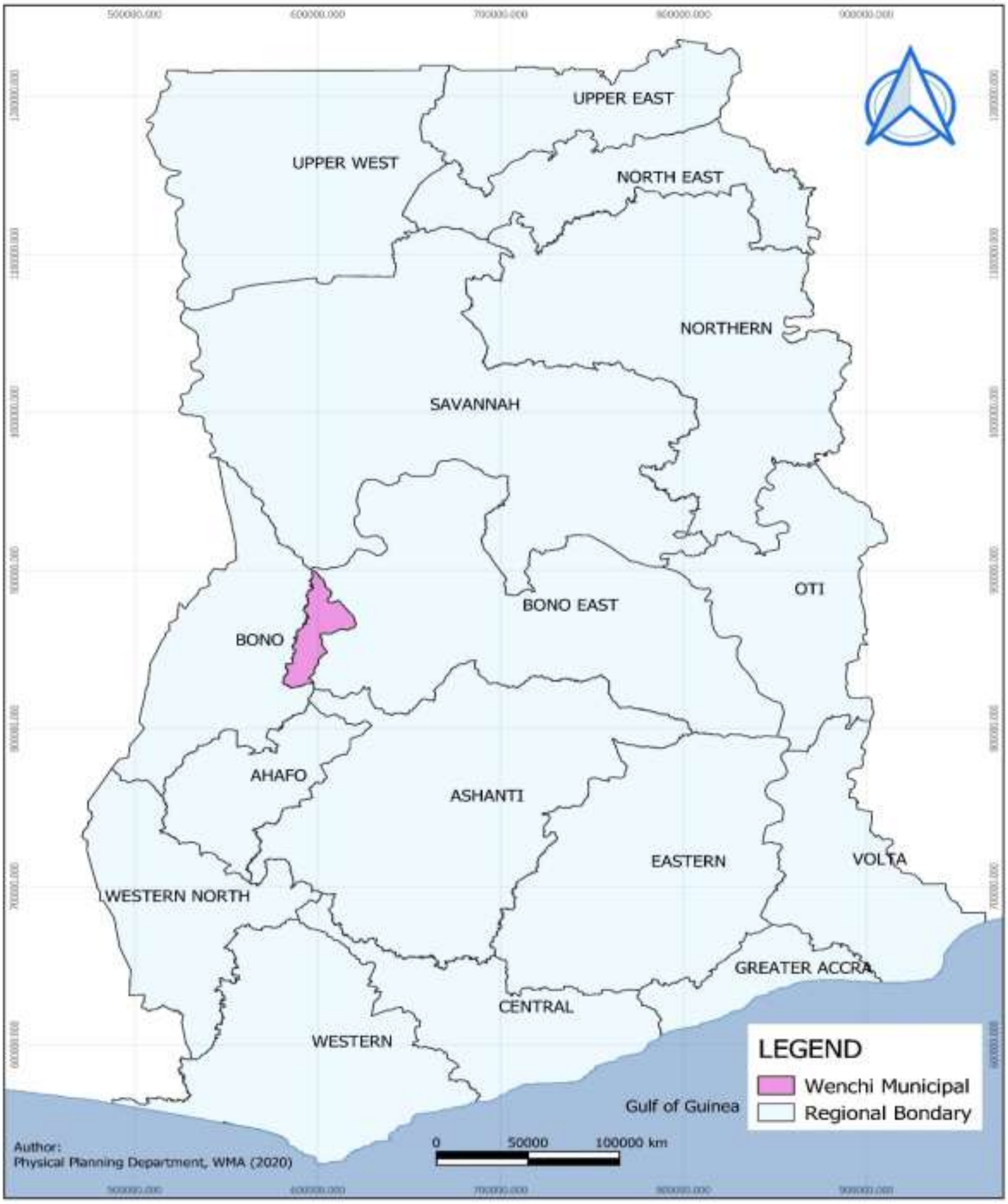

Figure 1a: Map of the Wenchi Municipality in Regional and National Context

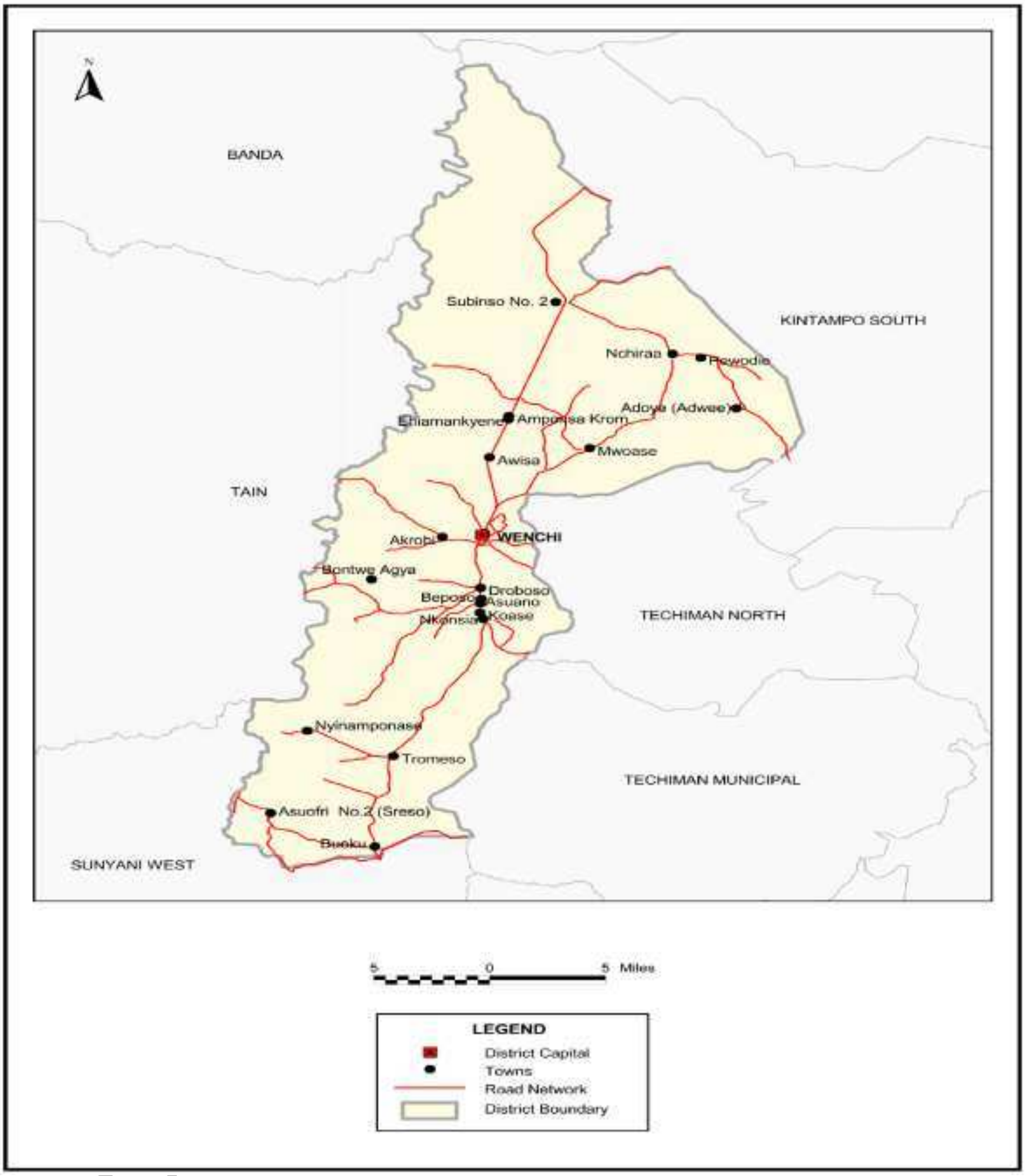

Figure 1b: Contextual Map of the Wenchi Municipality.

3.2 Measurement Instrument

To address the first research question (i.e., *which factors do stakeholders perceive to be the most important measures of river water quality*?), we applied a Likert type questionnaire to gather data in a survey. The Likert-type scales – a unidimensional scaling approach – are one of the most frequently applied psychometric measures for eliciting self- and other-reported perceptions (Hartley, 2014; Ho, 2017; Dunlap and LIERE, 1984). Critics of the Likert scale have raised concerns regarding the numerical nature of results, its associated problems of interpretation in a real-world setting and the rich information lost through the summation of results (e.g. Hinds et al., 2002). It must be noted that these are common limitations of quantitative studies. The Likert scale has many advantages that makes it useful: it is cheap and relatively fast to administer due to participants' familiarity with the tool (Froman, 2014; Hartley, 2014; Ho, 2017). Additionally, it allows us to compare results from groups and to generalise findings when a representative sample size has been applied and scales are well-validated (Hartley, 2014; Ho, 2017; Wakita et al., 2012; Dunlap and Liere, 1984; La Trobe and Acott, 2000; Van Liere and Dunlap, 1981).

The instrument applied in this research was adapted from previously validated studies on water resources management (e.g., Withanachchi et al., 2018) as relying on previously validated instrument provided a good basis to build on. Because the contexts differ, we needed to ensure that the data collection instrument was appropriate for our study area. To do this, we sent earlier versions of the survey instrument to senior academics, who then reviewed it. The senior academics provided useful insights on the wording and structure of the questionnaire. The questionnaire was revised using their feedback. We then pretested the instrument among five people from the study communities. Following the pretesting, the questionnaire was finalised (see appendix A1 for the final version of the questionnaire).

Survey participants were asked the question: "How important are the following factors when judging river water quality?" The factors include colour, taste, smell, clarity, and depth of river, aquatic vegetation and the presence of litter (faecal matter, plastics, polyethene bags) in and/or around the river. The responses were captured on a five-point scale (1 to 5), with 1 indicating low importance, and 5 suggesting high importance of the indicator as a measure of river water quality. For instance, selecting "very important" when asked about colour shows that the participant values the colour of river water as an important measure of water quality, hence, this scores 5, while others ("considerably important", "neutral", "a little important" and" not at all important") score 4, 3, 2 and 1 respectively. We included an open-ended question to gather views on other factors that are important to our interview participants: which factors (apart from the ones above) do you consider to be important when considering the quality of the river?

Our second research question was: *do stakeholders' perceptions of what constitute important measures of river quality influence judgement on the quality of rivers*? To address this question, we included a dichotomous response question aimed at evaluating stakeholders' general opinion on the quality of the rivers. Specifically, we asked survey participants to indicate their general opinion of river quality based on a direct observation[1] of the river environment through their visit to the river in the past 6 months.

[1] This method is well established in the literature, see e.g., ZUBE, E. H., FRIEDMAN, S. & SIMCOX, D. E. 1989. Landscape change: perceptions and physical measures. *Environmental Management,* 13, 639-644.

The responses to this question were "Polluted" or "Not Polluted". This allowed us to discriminate between participants who judged the river to be of bad quality as opposed to those who perceived the rivers to be of good quality, however the binary nature of responses does not reflect nuances or levels of pollution. Understanding levels of river pollution may be useful as it affects resource use. For instance, some stakeholders may use the river for certain purposes, but not others depending on how polluted they perceive it to be (de França Doria, 2010). Understanding this may help policymakers to influence behaviours regarding water resource use and how to maximise the potential of such resources. We included an open-ended question on why our participants perceived the rivers to be polluted or not polluted.

As our third research question aimed at identifying other factors (e.g., geospatial and sociodemographic variables) that may influence stakeholders' evaluation of river water quality, the questionnaire captured socio-demographic information (e.g., age, educational attainment, religion and gender of survey participants) and geo-spatial characteristics (e.g., residential location of participants).The last part of the questionnaire was aimed at identifying further qualitative data on other potential measures of river water quality. Here, survey participants were asked to state any other factors they considered as important measures of river water quality.

3.3 Research Approach, Data collection and Profile of Participants

We do not rely on a particular theory to investigate factors influencing water quality perceptions as the lack of a unified theory suggests that we would most likely miss out on other important factors (Schlüter et al., 2017). This decision is further justified by the fact that the scarce evidence on the topic are mostly from developed countries, whereas the present study focuses on a developing country. Therefore, we employed a hybrid of deductive and inductive approach by focusing first, on the (potential) factors identified in the literature, and second, using an exploratory approach to qualitatively identify additional factors that may influence water quality perceptions. This hybrid approach appears to be superior to applying purely a deductive or inductive approach as it guides the researcher through existing theoretical ideas while allowing for an exploration of new ideas. The interaction between existing knowledge and new ideas could consolidate existing evidence, and/or result in the production of new knowledge (Ragin, 1994).

A face-to-face survey was implemented in the three rural communities between May and June, 2019. The convenience sampling technique was employed to select individuals who were easily accessible. While this technique might be prone to biases arising from self-selection, it helps to conserve resources and allows for a wider population to be recruited (Hedt and Pagano, 2011). It is thought that the sample population of a convenience sampling technique is rarely representative of the general population, particularly, where the population is from people who visit a location (Hedt and Pagano, 2011).

However, this limitation does not apply to the present study as we visited different locations such as the riverside, market centres, schools, churches, pubs, open spaces and recreational centres to recruit participants.

About 314 persons were approached for interviews. However, 31 were not residents of the study communities and thus were excluded. This group of people were either travellers on a business trip, tourists or government workers who had visited the place, among others, and were therefore not well placed to offer a critical evaluation of the quality of rivers in the area. Initial interactions with some of these people revealed that they had not even visited any of the rivers in the area.

Of the remaining 283 persons, 17 had not visited the rivers in the last six months and therefore felt they were not confident about their perceptions of the rivers' quality. As this was becoming a common issue, we decided to focus on people who had visited the river in the last six months. Of course, as evidence suggests, self-reported surveys are usually faced with issues of memory bias (Kormos and Gifford, 2014). Additionally, it has commonly been assumed that six months is a considerable time for the water resources to have undergone significant changes due to seasonal dynamics in rainfall patterns. Excluding people who have not visited the rivers in the past six months may pose a potential limitation to the study. For instance, valuable information may be lost as we do not know 'anything' about why such people have not visited the rivers in the past six months. It is possible some of them view the water resources to be polluted and may pose risks to them, thus their decision not to visit these water resources. Exploring these views and the reasons for such perceptions would enrich the results and provide further insights for water policy and management decisions.

Additional 26 persons did not want to participate in the survey because they were either busy or were not comfortable. Therefore, a total of 240 responses were obtained from survey participants. Table 1 provides a summary of participants' socio-demographic and geo-physical characteristics. The survey was dominated by males, high school leavers, Christians and participants were relatively young, with a median age of 36[2]. Our sample comprised farmers, traditional medical practitioners, mechanics, teachers, health officials, civil servants, students, sanitation workers, timber operators, poultry breeders, food vendors, mechanical engineers, hydrologist, craftsmen, land administrators, assembly members and development workers (e.g., officials of NGOs).

[2] We report the median because the data was not normally distributed (see Appendix A2), thus making the mean an unreliable statistic in this case.

Table 1: Background Characteristics of Survey Participants

Variable	Group	Percentage
Gender	Male	59.6
	Female	40.4
Educational attainment	No qualification	13.3
	JHS/SHS	53.8
	Diploma or higher	32.9
Religion	Christian	73.8
	Muslim	22.9
	Others	3.3
Distance from residence to the river	Less than 1km	75.0
	1km and above	25.0
Source of water supply	Direct from rivers	5.8
	Indirect (e.g., through boreholes).	94.2
Years lived in community:	Median = 23.00; Mean = 25.29; standard deviation = 13.49	
Age:	Median = 36.00; Mean = 38.53; standard deviation = 11.32	

Notes: N=240; JHS= Junior High School; SHS=Senior High School; the category "others" under religion represents an Afrikaan and a Buddhist.

3.4 Analytical Methods

Data analysis begun with descriptive analysis to help us describe, summarize, and identify key patterns in the data, helping us to address our first research question. Next, we applied binary logistic regression models to explore hypothesised connections between the indicators of river water quality and participants judgement of water quality, aimed at addressing the second and third research questions. For instance, our second research question was: *does stakeholders' perception of what constitute important measures of river quality influence judgement on the quality of rivers*? Responses to this question were dichotomous i.e., "polluted" or "not polluted". Binary regression models fit well for such analysis as the dependent variable is dichotomous; i.e., the response takes one of only two possible values; polluted (1) or not polluted (0). While this statistical technique enabled us to explore relationships between the dependent and independent variables, the cross-sectional nature of the study does not allow us to establish some fundamental conditions for establishing causality. For instance, to establish causality, the researcher needs to establish contiguity and whether the cause precedes the effect. In the case of this study, because we were unable to establish these conditions, it was not possible to establish causality. Despite this limitation, the present study offers useful insights into factors that potentially influence stakeholders' judgement of river water quality.

Most of our independent variables were originally ordinal or scale values. For instance, as explained in section 3.2, responses to questions on the indicators of river water quality (e.g., taste, small, colour) were on a five-point Likert scale. Variables such as age and years lived in community were originally measured as scale variables. All variables, both scale and ordinal type were recoded to binary variables to allow for the application of the binary logistic models (see Table 2). To do this, the median value (of the scores obtained for each variable) was applied as a binary marker to classify responses into two groups: for the indicators, we classified responses into very important and less important. For respondents' age and years lived in the community, we classified them into old and young, and long stay versus short stay respectively. The medians applied as a binary marker for classifying responses into very important and less important appears to be ad hoc/arbitrary and may not apply to other populations. The median derived was based on the responses of survey participants which depends very much on their environmental knowledge and beliefs (Kormos and Gifford, 2014; Okumah et al., 2018; Gregory and Davis, 1993; Kenwick et al., 2009; Vouligny et al., 2009) thus making it subjective. These data must therefore be interpreted with caution because findings specific to medians cannot be easily extrapolated to all populations in Ghana. The binary marker depends on the context in which it is to be used; in a context where water pollution is a major problem, stakeholder views may vary as opposed to where pollution is limited. Additionally, this may be contingent on the characteristics of the sample population. Equation 1 specifies the general model that was applied in the regression analysis.

$$\text{logit}\{p(x)\}=\log\{p1-p\}=c+\beta 1x1+\beta 2x2+\cdots+\beta ixi \quad (1)$$

Where p is the probability of the observed result, c is a constant, and βi are the regression coefficients of the explanatory variables of xi. Multicollinearity is not an issue in the present study as the explanatory variables are mostly not correlated or are poorly correlated (see Appendix A3, see also, (Sapra, 2014)). We applied a content analysis approach to explore the qualitative data. Qualitative data was reported using a manifest style (e.g., Bengtsson, 2016), by supporting arguments with key statements from survey participants.

Table 2: Variable codes for binary logistic regression

Variable	Group	Codes
Gender	Male	1
	Female	0
Educational attainment	No qualification	1
	Others	0
	JHS/SHS	1
	Others	0
	Diploma or higher	1
	Others	0
Religion	Christian	1
	Others	0
	Muslim	1
	Others	0
	Afrikaan or Buddhist	1
	Others	0

Distance from residence to the river	Less than 1km	1
	1km and above	0
Source of water supply	Direct from rivers	1
	Indirect (e.g., from boreholes).	0
Years lived in community:	Short (stayed in community for up to 23 years) = 1; long (23+) = 0	
Respondents age category:	Young (below 36 years) = 1; Old (36+) = 0	
Depth of river	Less important (rated 1or 2) = 1; Very important (values from and above 3+) = 0	
Aquatic vegetation	Less important (rated 1or 2) = 1; Very important (values from and above 3+) = 0	

4. RESULTS

4.1 Evaluation of Survey Responses: which factors do stakeholders perceive to be the most important measures of river water quality?

Table 3 provides a summary of responses to survey questions on indicators of river water quality. Results show that with the exception of two indicators (depth of river and presence of aquatic vegetation), the mean rank values for all indicators were high. This suggests that survey participants perceive these indicators as very important measures of river water quality. Figure 2 shows that the presence of faecal matter in and/or around the river was the most important measure of river water quality while depth of river was the least important. This finding is reinforced by results in Appendix A3, where over 60% of participants rated the presence of faecal matter (faeces) to be very important, while less than 10% rated depth of the river and aquatic vegetation as very important measures of water quality. These findings are also consistent with qualitative results from survey participants (see section 4.3). Results further suggest that majority of survey participants (79.2%) perceived the rivers to be polluted.

Table 3: Evaluation of participants' responses

Indicator	Mean	Std. Error	Std. Deviation	Median
Colour	4.11	0.047	0.724	4
Taste	4.07	0.053	0.815	4
Smell	4.28	0.050	0.777	4
Clarity/Transparency	4.20	0.050	0.770	4
Plastics, polyethene bags	4.42	0.051	0.794	5
Aquatic vegetation	2.79	0.074	1.142	3
Presence of faecal matter (faeces)	4.54	0.050	0.775	5
Depth of the river	2.44	0.073	1.134	3

N= 240; Std. Error = standard error, Std. Deviation = Standard deviation; N = Number of participants.

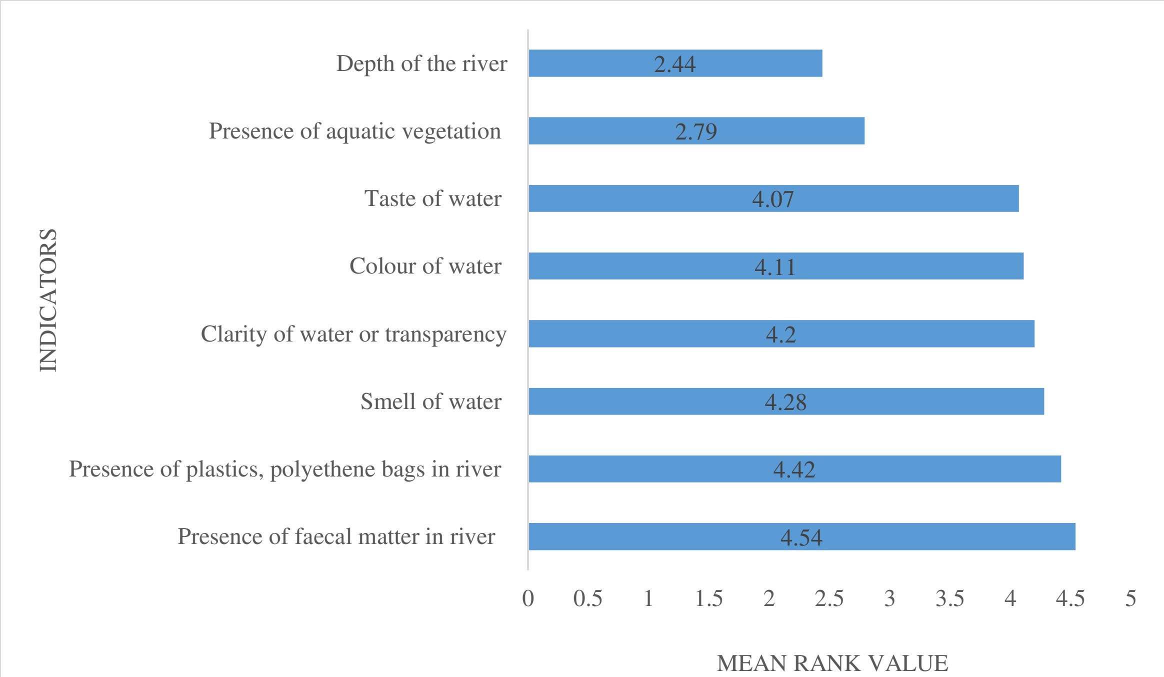

Figure 2: Summary of responses on important measures of river water quality

4.2 Does stakeholders' perception of what constitute important measures of river water quality influence judgement on the quality of rivers?

This section focuses on whether stakeholders' perception of what constitute important indicators of river water quality predicts their judgement on the quality of rivers. We note that there was a lack of variance in the data for most of the indicators (see Appendix A3), thus precluding a meaningful inferential analysis. Our analysis therefore included only views on presence of aquatic vegetation and depth of river. Results of a binary logistic regression show that perceptions of aquatic vegetation and depth of river as indicators of river water quality were influential drivers of stakeholders' judgement of river water quality (see Table 3). The results suggest that people who perceived aquatic vegetation to be a very important indicator of river water quality were more likely to have reported that the rivers were polluted.

On the other hand, people who perceived the depth of river as a very important indicator of river quality were less likely to have reported that the rivers are polluted. This might suggest that participants who view depth of a river to be important have probably not observed a decline in the depth of the rivers. However, some comments from interview participants suggest that depth of a river is an important measure of water quality. For instance, a farmer noted that:

> "*During our boyhood days, we had fun in these rivers due to how clean the river was. One could delve deep into the rivers when swimming due to the depth. Same cannot be said about the current state of the river in terms of depth. The huge piles of sand and rubbish have caused the river to be shallow*" (Farmer, Age 58).

This participant believes the river is polluted because they feel the depth of the river had reduced attributable to the deposition of pollutants (e.g., rubbish). There were contrary views on whether depth is important or not. For instance, a respondent indicated that:

> "*I believe to a large extent; the depth of rivers depends on the way the water flows. The powers of the running water carry a lot of sand and eventually deposits them into the river. Will you say sand is dirt? Sand is a natural thing, and it is clean*" (Development worker, Age, 36).

Although we did not include indicators such as taste, colour, smell, clarity and sanitary conditions (e.g., faecal matter, and plastics) due to a lack of variation in the dataset, evidence from the qualitative data suggests that some of these variables could have an influence on stakeholders' judgement of river water quality. For instance, one sanitation worker highlighting the relevance of pollutants and taste noted that:

> "*The farmers here nurse their seeds very close to the river and they apply agro-chemicals on their farms. When there's heavy downpour, it washes the poisonous agro-chemicals into the river. Don't you think this will affect the village people who drink from the river? I remember when I visited the village, my mother said the water doesn't taste nice again even after adding lemon, lime and orange*" (Sanitation worker, Age 43).

On sanitary conditions and the presence of faecal matter (faeces), a participant mentioned that:

> *"In recent times, it's common to come across huge piles of rubbish along the river bank. Farmers and people passing by the river dispose off solid and liquid waste into the water bodies. Some people even defecate into the rivers. But when we were young, say 30-35 years ago, it was very rare to come across waste along the rivers because people were scared of the punishment from the gods and our ancestors" (*Mechanical Engineer, Age 35*).*

Another participant, comparing the sanitary conditions of River Yooyo to other rivers mentioned that:

> "*Anytime you visit the river after a heavy downpour; you could find all sort of human waste along the rivers. Isn't this enough to tell you that the river is polluted? I don't see this when I visit some rivers in other parts of the country. We need to do something about the problem*" (University Student, Age 21).

From the qualitative interviews, we can conclude that almost all the indicators considered in our study potentially influence people's judgement of river water quality. Evidence, from the qualitative data further suggests that while these indicators seem to be important to survey participants, how they are applied in judging river water quality varies. While some participants compare the attributes (e.g., taste, colour, sanitary conditions) of the same river over time, others compare the attributes of one river to those of other rivers to draw their conclusions.

Table 4: Effects of perceptions on river quality judgements

Variables	B	S.E.	Wald	df	p-value	Exp(B)
Vegetation	0.998	0.331	9.098	1	0.003***	0.369
Depth	-0.716	0.336	4.542	1	0.033**	2.046

Notes: ***p-value < 0.01, * *p-value < 0.05, *p-value < 0.1; df = degrees of freedom; S.E = standard error

4.3. Which other factors might influence stakeholders' views on the quality of rivers?

While section 4.2 investigated the relationship between perceptions of indicators and judgement of river water quality, this section looks at whether other variables such as socio-demographic and geo-spatial factors influence stakeholders' evaluation of river water quality. A binary logistic regression was performed to determine the influence of age, gender, educational attainment, religion, and years lived in community as well as the distance between respondents' residence and river on river water quality evaluations. Results show that age, education and number of years a respondent had lived in the community influenced their judgement of river water quality: $\chi 2$ (240) = 12.623, p-value < .10 (see Table 4). Specifically, we found that older people, high school leavers and people who had lived in the community for longer periods were more likely to have reported that the rivers were polluted. The model explained 8.0% (Nagelkerke R^2) of the variation in river water quality judgement and correctly classified 79.2% of cases.

Additional qualitative data suggests that perceptions on how close a river is to potential pollution sources may influence people's judgement. Some respondents indicated that the river was polluted because of its closeness to animal slaughterhouse, thus exposure to animal waste and blood; closeness to farms where fertiliser and other agro-chemicals are applied; human settlement and thus exposure to household waste; and closeness to refuse disposal site. Two people noted that cows drink from the river and dead organisms such as insects, crabs, fowls, fishes and snakes were found in the rivers. One participant pointed out that while he believed that their perception of river quality was useful, *"[assessment of] river water quality must rely on scientific indicators such as PH, oxygen concentration, temperature and presence of bacteria/fungus*".

Table 5: Effects of Socio-demographic and geo-physical factors on river quality judgements

Variable	Estimate	S.E.	Wald	df	p-value	Exp(B)
Age	0.978	0.387	6.393	1	.011**	0.376
Gender	0.107	0.339	0.099	1	0.753	1.113
Religion	-0.279	0.361	0.599	1	0.439	0.756
Distance from residence to the river	-0.220	0.393	0.314	1	0.575	0.803
Years lived in community	0.690	0.382	3.266	1	0.071*	1.994
Educational Level	0.672	0.332	4.108	1	0.043**	0.510

Notes: ***p-value < 0.01, * *p-value < 0.05, *p-value < 0.1; df = degrees of freedom; S.E = standard error

5. DISCUSSION

Drawing on empirical data, this study aimed at evaluating important measures of river water quality and factors influencing stakeholders' judgement of river water quality in the Wenchi Municipality in Ghana. Results suggest that the presence of faecal matter in and/or around the river was the most important measure of river water quality while depth of river was the least important. This finding aligns with those of Yeleliere et al. (2018) whose review revealed that faecal coliforms are among the most commonly found pollutants in almost all surface waters in Ghana. Indeed, the presence of faecal matter is of serious concern to stakeholders because as the level of faecal matter in and/or around the river increases, there is a low valuation by stakeholders in terms of the river use for picnicking, scenic beauty and domestic consumption. A possible explanation for this finding may be that river sites with litter are not suitable for fish propagation and drinking, even if such waters are purified (Dinus, 1981). On the other hand, the depth of river may be regarded a less important measure of river water quality because, although not easily determined, the public perceive that the depth of a river to a large extent is determined by the flow of eroded water during heavy rains. The magnitude of erosion might further wash away the river bed, thus, deepening the depth of the river; on the other hand, where the erosive power of the flowing water is weak, the amount of sand or sediments being transported might be deposited into the river, which they believe, might alter the actual river depth by reducing it. It seems possible that survey participants do not perceive these materials (sand/sediments) to be pollutants and hence a less important indicator of river quality.

Among the five organoleptic properties, taste was the least important. This observation suggests that there may be a link between the use of water resources and what constitutes an important measure of water quality. It appears the taste of water is important when it is used directly for drinking (de França Doria, 2010). The background characteristics of survey participants (Table 1) revealed that only about six percent of respondents indicated that the river is a direct source of water to them. By extension, only a minority use the river water for drinking hence, taste might not matter to them.

Whether aquatic vegetation is an influential driver of stakeholders' judgement of river water quality or not remains contested in the literature. Some empirical studies report that the presence of aquatic vegetation could either positively or negatively affect people's perception about the quality of the water resource (e.g., Moser, 1984; Steinwender et al., 2008). In the work of Cottet et al. (2013), presence of floating aquatic vegetation in nutrient-rich rivers were perceived as having no aesthetic value whiles submerged vegetation living in nutrient-poor rivers were judged as having considerable aesthetic value. Our results suggest that although stakeholders reported that the presence of aquatic vegetation was not a very important measure of water quality, perceptions of this indicator are drivers of water quality judgements. We found that people who perceived aquatic vegetation as a very important indicator of river water quality were more likely to have reported that the rivers are polluted. This finding corroborates the results of a recent study in Ghana (Gyasi et al., 2018) which reported that residents around the Bui Dam catchment in Ghana perceived that the construction and subsequent operation of the multi-purpose dam had led to the submerging of aquatic vegetation and organisms. The residents perceived the river to be contaminated and were compelled to use other water sources such as bottled and sachet water. This has implications on the expenditures of residents as they are more likely to commit a substantial portion of their earnings to purchase treated water, thus raising questions on affordability. This makes concerns regarding water quality perceptions an important policy issue because the UN SDG 6 encourages governments to ensure availability and sustainable management of water for all, and at an affordable price (United Nations, 2016a, 2016b; United Nations Environment Programme, 2017).

We were unable to test whether organoleptic properties such as taste, smell and colour are drivers of stakeholders' judgement of river water quality due to lack of variation in the dataset. However, evidence from qualitative data suggests that taste is an important driver of stakeholders' judgement. Furthermore, from past empirical studies, these variables have been found to be key factors influencing public perception of river water quality. For instance, Smith and Davies-Colley (1992) found that visual factors such as colour and clarity are key in determining water quality as it suggests to users, the possibility of toxicity (see also Thornton and McMillan, 1989). They further observe that colour is critical by virtue of the aesthetic appeal. When the river site has litter, is discoloured and has odour, stakeholders are more likely to rate such rivers as contaminated, even if it has the finest quality in terms of PH, temperature, turbidity and presence of dissolved oxygen (Dinius, 1981). The discoloration of rivers will thus generate public rejection of the use of the resource and might result in behaviours that are counterproductive to the goals of environmental sustainability. For instance, some people may discharge human and industrial waste into the rivers when they perceive such resources to be poor owing to their discoloured nature. This has further implications for public health and health care expenditure (Abraham et al., 2016). On the other hand, favourable perception by the public in terms of the colour and clarity of water resources to a large extent influences the public to rate the river as acceptable and hence fit for human use (Smith and Davies-Colley, 1992). Taken together, these suggest that colour and clarity are important as they shape perception with respect to domestic and recreational use of surface freshwaters (Smith and Davies-Colley, 1992). However, Dinius (1981) notes that discoloration of rivers was considered not harmful for industrial use. Moreover, there is limited evidence that the protection of clarity and colour of water resources will serve to safeguard ecological values (Kirk, 1988).

In relation to smell, Dinius (1981) found that odour is the most highly correlated predictor of overall pollution and influences perception of river quality. For many stakeholders, pungent or unpleasant smell emanating from the river is an indication that the river is unclean and therefore of low quality (Abraham et al., 2016). It is thought that some stakeholders may view the extent of the odour as an index of the severity of water pollution. A recent study in Ghana (Abraham et al., 2016) found that in such circumstances, the public tends to perceive these water resources as channels for the flow of waste water. If Abraham et al.'s (2016) findings are accurate, then surface water with unpleasant smell were perceived to have lost their value as rivers (i.e., resources) and were merely regarded as a conduit through which waste water and industrial effluents flows. This perception therefore triggers negative sanitary practices among the populace as they begin to dump waste into the river. A good example is the case of the Odaw River located in the capital city of Ghana, Accra, where sections of the general public perceived the river to be in a deteriorating state and this was evident because the river contains 'everything', ranging from human waste to industrial effluents from the Accra Brewery Company Limited (Abraham et al., 2016). Residents were motivated to discharge human and industrial waste into the river, with serious implications for public health and the perennial floods experienced in Accra. This is because as human and industrial wastes are discharged into the rivers (resulting from the low value perceptions), there is the tendency that such rivers might be filled with filth, thus obstructing the flow of run water during heavy downpours and increasing the risk of flooding.

The last objective of the study was to explore additional socio-demographic, geo-spatial and contextual factors that may influence perceptions of water quality. In line with the findings of earlier studies (e.g., Nassauer, 1992; Augoyard, 1995), we found that water quality perceptions depend on age and number of years a person has lived in a community. A probable explanation to this finding is that adults and persons who have lived in a community for longer periods may have observed for instance, the clarity or colour of the rivers previously and are much more likely to report a significant change in such attributes and thus in the quality of the river. We also observed the potential role of education as high school leavers were more likely to have reported that rivers were polluted. Although, past studies (e.g., de França Doria, 2010) have suggested that educational levels may affect perceptions regarding water quality, we believe this result may be due to a potential confounding effect of age. Result of a simple cross tabulation shows that among the older population, the proportion of high school leavers was slightly lower (49.6%) than the other group (51.4%). Given that older people were more likely to have reported poor river quality, the results that education affects perception of river quality could be attributed to a potential confounding effect of age. Earlier studies have indicated that demographic factors are usually closely related (de França Doria, 2010) and their effect on water quality judgement is likely to be mediated by contextual factors, (Johnson, 2003) thus, making it difficult to establish causal effects. As this remains unsettled, these results therefore need to be interpreted with caution. Additionally, there is the need for further research that involves the application of multivariate statistical techniques to explore the interactions between age, education and other variables, while controlling for confounding effects.

Furthermore, there is some evidence to suggest that culture provides an avenue for socially constructed myths about natural resources, which interacts with people's opinions and shape their interpretations (e.g., Douglas, 1966; Adamtey et al., 2014). How people evaluate river water quality may depend on the spiritual roles attributed to it – e.g., for baptism and ablution – which defines purity (de França Doria, 2010). Some researchers have noted that the religious view of good quality water may interfere with perception of it as being polluted or not in ecological or biophysical terms, but this may trigger pro-environmental behaviours (de França Doria, 2010). This suggests that cultural and religious variables may be important moderating factors in people's judgement of river water quality, however, we were unable to test this due to lack of variance in the dataset (see Table 1). Further research is needed to test whether indeed cultural and religious factors are drivers of stakeholders' judgement of river water quality in the developing world. In line with earlier studies, we found that contextual factors such as perceptions regarding pollution sources (e.g., how close a river is to potential pollution sources) may influence people's judgement of river water quality.

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

The goal of this study was to advance understanding of what constitutes important measures of river water quality as well as factors influencing stakeholders' perceptions. Our findings are in agreement with earlier works on the topic, specifically on the influence of aquatic vegetation and socio-demographic factors on river water quality judgements. We note, however, that only a few of the past studies (e.g., Johnson, 2003) investigate the effect of these indicators on water quality perceptions (as we have done in this study); they only establish the statistical significance and strength of correlations between two of them at a time. The added value of our study therefore lies in the methodological application i.e., the logistic regression models that enabled us to explore whether the independent variable predicts the dependent variable, thus enabling us to explore the direct effects of multiple variables on water quality perceptions. This considerably advanced statistical technique and the qualitative data consolidate the evidence that the variables considered in this study appear to be crucial drivers of river water quality perceptions.

Our findings suggest that while variables such as taste, colour, smell and litter (e.g., plastics, and polythene bags) are important, the presence of faecal matter in and/or around the river was the most important measure of river water quality while depth of river was the least important. This has implications for water management agencies as they should endeavor to make the river aesthetically appealing for public acceptability and subsequent utilization. This also reduces the extent of risk that the public attributes to the use of water resources (Smith and Davies-Colley, 1992). Incorporating these variables in the measurement of water quality or indexing systems would be of great importance to water management agencies. Furthermore, efforts to manage water quality must focus considerable attention on keeping the river and the riverbank clean as stakeholders may not recognize the benefits of water resource management interventions or policies if they are not directed at keeping the river clean. We note, however, that the extent to which water management authorities address this concern depends on resource availability because where a water management authority has a limited ability to treat water (which appears to be a common challenge in many developing countries), they must prioritise health and ecological factors over aesthetics.

In addition, while some indicators seem to be valuable for certain uses (e.g., recreation, drinking), they may not represent ecological quality or damage to river ecosystems and thus their enhancement may not yield an ecological value. Moreover, a single indicator perspective may be a weak approach because, for instance, water may be of good colour but may have been contaminated. As one participant noted, although understanding perceptions of river quality is useful, "[assessment of] river water quality must rely on scientific indicators such as PH, oxygen concentration, temperature and presence of bacteria/fungus". Indeed, while stakeholders' perceptions of river water quality could guide water management policies, scientific measurements of water quality must not be replaced with stakeholder perceptions. This is because aspects such as ecological integrity may not be important to some stakeholders or segments of the public but is an important aspect of water management. This is reinforced in the present study as there seem to be a lack of concern among the participants regarding river depth – an important factor for habitat provision and pollution dilution. Secondly, perceptions of what is important may not reflect ecological value, therefore, relying on a few indicators (that are not comprehensive) may result in policies not meeting resource users' expectations or protecting ecological value of water resources. It is therefore important that scientifically measured data are collected to complement perceptions (Withanachchi et al., 2018).

Taken together, the findings from this study suggest that policymakers and regulators should consider stakeholders' perceptions of the quality of rivers as this provides insights into water resource management. For instance, where stakeholders perceive water to be of poor quality due to the presence of aquatic vegetation, they are more likely to have unfavorable attitudes towards the resource. Therefore, authorities such as the Ministry of Water Resources, Environmental Protection Agency, and Community Water and Sanitation Agency should take urgent steps to investigate what kind of aquatic vegetation they are, whether they are ecologically useful and/or harmful to human and other living organisms. If such investigations reveal that the different types of aquatic vegetation are harmless, awareness raising is needed to make the public understand for instance, the ecological value of aquatic vegetation and why they are harmlessness to human health. This is because negative perceptions could deter people from using water resources for various purposes (e.g., recreation and fishing) which are important livelihood sources in many resource dependent communities. Ultimately, this reduces the value of water resources and the benefits they offer to humanity, particularly, the inhabitants of the surrounding communities. Additionally, improving stakeholders' understanding could help prevent pollutive behaviours that arise from negative perceptions of river water quality.

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8. APPENDICES

Appendix A1: Questionnaire

1. Age of Respondent:

2. Gender of Respondent:

3. Educational Level: a) no formal education b) up to high school certificate (e.g., JHS, SHS) c) Certificates above high school (e.g., diploma, first degree, masters)

4. Religion: a) Yes b) No

5. Specify religion if Yes: a) Christian b) Moslem c) Others

6. Please indicate your source of water supply: a) Direct from rivers b) indirect (e.g., through pipes)

7. What is the distance from your residence to the river: a) Less than 1km b) 1km and above

8. How many years have you lived in the community?

9. Please, how important are the following (indicators) factors in deciding whether river quality is good or bad?

Variable	Responses				
	Not at all important	A little important	Neutral	Considerably important	Very important
Colour					
Taste					
Smell					
Clarity/transparency					
Presence of external objects (e.g., plastics, polythene bags) in river.					
Presence of aquatic vegetation in river.					
Presence of waste (e.g., faeces, plastics, polythene bags) around riverbank river.					
Depth of river					

10. What are your general opinions about river quality: A) Polluted B) Not Polluted

11. Please explain why the river is polluted or not polluted?

12 Is there any other factor(s) you consider important as a measure of river quality? Please state and explain them below.

Appendix A2: Normality Test Results

Variable	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age in years	0.146	240	0.000	0.940	240	0.000
Years lived in community	0.125	240	0.000	0.958	240	0.000
Colour	0.261	240	0.000	0.817	240	0.000
Taste	0.267	240	0.000	0.825	240	0.000
Smell	0.257	240	0.000	0.763	240	0.000
Clarity	0.250	240	0.000	0.795	240	0.000
Presence of litter (e.g., plastics, polyethene bags)	0.313	240	0.000	0.679	240	0.000
Aquatic vegetation	0.206	240	0.000	0.907	240	0.000
Presence of faecal matter (faeces)	0.362	240	0.000	0.592	240	0.000
Depth of the river	0.193	240	0.000	0.887	240	0.000

N = 240

Appendix A3: Responses to survey questions

Indicators	Responses/Rank				
	1	**2**	**3**	**4**	**5**
Colour	0.0	1.7	16.3	51.6	30.4
Taste	0.0	5.0	15.0	48.3	31.7
Smell	1.3	0.8	10.0	44.6	43.3
Clarity	0.8	1.3	12.9	47.5	37.5
Presence of litter (e.g., plastics, polyethene bags)	2.1	0.4	5.4	37.5	54.6
Aquatic vegetation	16.7	20.0	38.3	17.5	7.5
Presence of faecal matter (faeces)	2.5	0.0	2.5	31.3	63.7
Depth of the river	27.1	22.5	33.3	13.3	3.8

N = 240; 1 = Not at all important; 2 = A little important; 3 = Neutral; 4 = considerably important; 5 = Very important; Values represent proportion of survey participants

Appendix A4: Correlations between Indicators

		Colour	Taste	Smell	Clarity	Plastics, Polyethene bags	Aquatic vegetation	Faeces, around the river bank/river	Depth of the river
Colour	Correlation Coefficient	1.000	0.114	0.154*	0.149*	0.027	0.257**	0.136*	0.147*
	Sig. (2-tailed)	.	0.078	0.017	0.021	0.679	0.000	0.035	0.022
	N	240	240	240	240	240	240	240	240
Taste	Correlation Coefficient	0.114	1.000	0.040	0.024	0.186**	0.208**	0.031	0.075
	Sig. (2-tailed)	0.078	.	0.534	0.713	0.004	0.001	0.631	0.244
	N	240	240	240	240	240	240	240	240
Smell	Correlation Coefficient	0.154*	0.040	1.000	-0.193**	0.025	0.098	0.058	0.159*
	Sig. (2-tailed)	0.017	0.534	.	0.003	0.697	0.129	0.373	0.014
	N	240	240	240	240	240	240	240	240
Clarity/Transparency	Correlation Coefficient	0.149*	0.024	-0.193**	1.000	-0.116	0.111	0.415**	0.043
	Sig. (2-tailed)	0.021	0.713	0.003	.	0.074	0.087	0.000	0.506
	N	240	240	240	240	240	240	240	240
Presence of plastics, polyethene bags	Correlation Coefficient	0.027	0.186**	0.025	-0.116	1.000	.0134*	0.077	0.021
	Sig. (2-tailed)	0.679	0.004	0.697	0.074	.	0.038	0.237	0.749
	N	240	240	240	240	240	240	240	240
Presence of aquatic vegetation	Correlation Coefficient	0.257**	0.208**	0.098	0.111	0.134*	1.000	0.059	0.275**
	Sig. (2-tailed)	0.000	0.001	0.129	0.087	0.038	.	0.365	0.000
	N	240	240	240	240	240	240	240	240
Presence of faecal matter (faeces)	Correlation Coefficient	0.136*	0.031	0.058	0.415**	0.077	0.059	1.000	-0.015
	Sig. (2-tailed)	0.035	0.631	0.373	0.000	0.237	0.365	.	0.821
	N	240	240	240	240	240	240	240	240
Depth of the river	Correlation Coefficient	0.147*	0.075	0.159*	0.043	0.021	0.275**	-0.015	1.000
	Sig. (2-tailed)	0.022	0.244	0.014	0.506	0.749	0.000	0.821	.
	N	240	240	240	240	240	240	240	240

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).