Check for updates

Natural language processing of spatially crowdsourced data in petroleum revenue management

Michael Ogbe

Abstract It has been over a decade of petroleum revenue utilisation in Ghana. Yet, there is a dearth of research on Ghanaians' sentiments on petroleum revenue management in Ghana. However, research indicates that investigating citizens' sentiments and addressing their grievances could prevent conflicts and promote better revenue utilisation in natural resource-rich countries. So, this study investigated Ghanaians' sentiments about petroleum revenue management and its contribution to the Free Senior High School (SHS) programme in Ghana through an online survey. The study employed the quantitative approach in which the data was gathered through an online survey questionnaire and analysed using natural language processing techniques. The results show that the participants had negative sentiments about petroleum revenue management and the Free SHS programme in Ghana. However, they trust the managers and anticipate better revenue management in the future. The study recommends that the government should consult broadly with all stakeholders regarding petroleum revenue management to avoid potential conflicts. The article concludes that petroleum revenue managers can combine spatial crowdsourcing and natural language processing to extract citizens' opinions at specific locations for better revenue management.

Keywords Natural language processing · Sentiment analysis · Spatial crowdsourcing · Petroleum revenue management · Ghana

Introduction

In natural resource-rich extracting countries, citizens usually have a strong sense of right to own the resources and must benefit from the revenues (Brunnschweiler et al., 2021; Gudynas, 2016; Lange & Kinyondo, 2016; Must, 2018; Paler, 2013). When citizens perceive that their governments are depriving them of their fair share of the common resource, they can violently confront the governments (Must, 2018; Sefa-Nyarko, 2016). So, in the general natural resource management literature, scholars advocate for resource-rich governments to engage their citizens (Brunnschweiler et al., 2021; Ghose et al., 2018; Ogbe & Lujala, 2021). Citizens need to know how much revenue their governments get from natural resource extraction, have a say in the revenue utilisation, and feel that the revenue-funded projects meet their needs (Ogbe & Lujala, 2021; Ogbe et al., 2021). Thus, to avoid conflicts and ensure better revenue utilisation, governments should investigate their citizens' sentiments and address their grievances (Rihoy et al., 2007; Romero Valenzuela, 2020). Identifying

M. Ogbe (✉)
Department of Geography, Norwegian University
of Science and Technology, 7491 Trondheim, Norway
e-mail: michael.ogbe@ntnu.no

citizens' sentiments, for example, through their written comments, about public policies or services is essential for effective development (Prabowo & Thelwall, 2009). Knowing how the public relates to a particular service—positive, negative, or neutral—can help governments or decision-makers to provide better services.

Available research indicates that through sentiment analysis, a subfield of natural language processing, governments can identify the sentiments in public expressed comments (Hemmatian & Sohrabi, 2019; Liu, 2020; Singhal et al., 2018; Yang & Cardie, 2014). Though sentiment analysis is paramount in politics, governance, and business (Akanksha & Sharma, 2018; Shah & Patel, 2014), it has little attention within natural resource revenue management. Hence, this study used sentiment analysis to extract the feelings, emotions, and opinions in spatially crowdsourced Ghanaians' comments on petroleum revenue management in Ghana.

Since 2011, the Ghanaian government has financed numerous community and national development projects in Ghana using the Annual Budget Funding Amount (ABFA), a designated portion of petroleum revenue in the country (Ogbe et al., 2021). At the end of 2020, the ABFA had received about US$2.5 billion and financed over 1000 projects amounting to about US$2.3 billion (Ministry of Finance, 2021; PIAC, 2021). A notable fully funded ABFA project in Ghana is the Free Senior High School (Free SHS) programme. The Free SHS programme started in 2017, and it absorbs all expenses like tuition, feeding, and accommodation for every senior high student in Ghana. From the year 2017 to the end of 2020, records from the Ministry of Finance (2021) indicate that the Free SHS programme alone had received about 40% of the total utilised ABFA (US$980 million).

So far, there is evidence, for instance, that Ghanaians' preferred projects for ABFA funding vary geographically (Ogbe et al., 2021). Concerning the specific case of the Free SHS programme, we know that the government did not consult all stakeholders in the education sector before implementing the programme (Cudjoe, 2018; Mohammed & Kuyini, 2021). Moreover, some Ghanaians think that the Free SHS programme only encourages students' enrolment and not the quality of senior high education in Ghana (Abdul-Rahaman et al., 2018; Adarkwah, 2022; Adu-Gyamfi

et al., 2020). What we do not know yet is the sentiments Ghanaians have on petroleum revenue management. For better revenue utilisation, it is important to investigate whether Ghanaians trust the government to manage petroleum revenue or the type of emotions they have concerning the revenue management. Such a timely investigation can help the government to identify aggrieved citizens and engage them to prevent future conflicts regarding petroleum revenue management.

With a quantitative methodology and sentiment analyses of written comments from an online survey, this study investigates Ghanaians' sentiments about general petroleum revenue management and the specific case of the Free SHS programme. The Free SHS programme is the government's most prioritised programme and is widely advertised and debated in Ghana (PIAC, 2021). So, the study assumes that most Ghanaians could be aware of it and comment on it.

The study's overall objective is to identify the sentiments of Ghanaians regarding petroleum revenue management in Ghana. Specifically, the study assessed two research questions:

- RQ1: What sentiments do Ghanaians have about petroleum revenue management in Ghana?
- RQ2: What sentiments do Ghanaians have about the Free SHS programme in Ghana?

Review of related literature

Previous research

Ghana's petroleum revenue management has attracted numerous research within the first decade. These studies largely revolve around the Ghana government's adherence to the Petroleum Revenue Management Act (Stephens, 2019), transparency and accountability (Graham et al., 2019; Gyampo, 2016; Lujala et al., 2020; Ofori & Lujala, 2015), and Ghanaians' engagement in petroleum revenue management (Brunnschweiler et al., 2021; Ogbe & Lujala, 2021; Ogbe et al., 2021).

Petroleum revenue management act

Regarding the Petroleum Revenue Management Act (PRMA), Stephens (2019) observed that though the

government is generally adhering to the Act, there are challenges concerning revenue collection and utilisation. He stated that the government has not managed to collect all petroleum revenue due to the nation. For instance, despite the mandatory annual payment of surface rentals from the upstream companies in the Act, "the Ghana Revenue Authority has failed to ensure that there has been payment of surface rentals in a diligent manner" (Stephens, 2019, p. 127). In a related publication, the PIAC, in its 2015 annual report, indicated that the revenue authority failed to trace the companies' owners, hence, their inability to ensure the payments (PIAC, 2016, p. xii). Although the PIAC called on the revenue authority to recover all outstanding surface rentals that the upstream companies owed the state, which at the time was about US$722,000, one cannot tell if the authority did that as there are no records to that effect. In respect of revenue utilisation, Stephens indicated that political interference "has led to an unsatisfactory utilisation" (Stephens, 2019, p. 119). For instance, the Ministry of Finance has misappropriated the revenue allocated for development projects and, in some cases, spread the allocated revenue on too many concurrent projects. In all, Stephen concluded that the government needs to strictly adhere to the PRMA and utilise petroleum revenue more judiciously to have a transformative effect on Ghanaians.

Transparency and accountability

Concerning transparency and accountability, the available research indicates that the government needs to be more effective. Regarding transparency in terms of information disclosure, there are available reports, for instance, on disbursements of petroleum revenue to the ABFA from the PIAC and Ministry of Finance. However, as Ofori and Lujala (2015) indicate, this transparency is "illusionary" because the information is in the English language and online. Hence, some Ghanaians cannot access it as one needs the capacity to read in English and the Internet to get such information. In their study investigating transparency within petroleum revenue management in Ghana, Lujala et al. (2020) observed that compared with the urban, educated, and leaders (political or traditional); the rural, uneducated, and
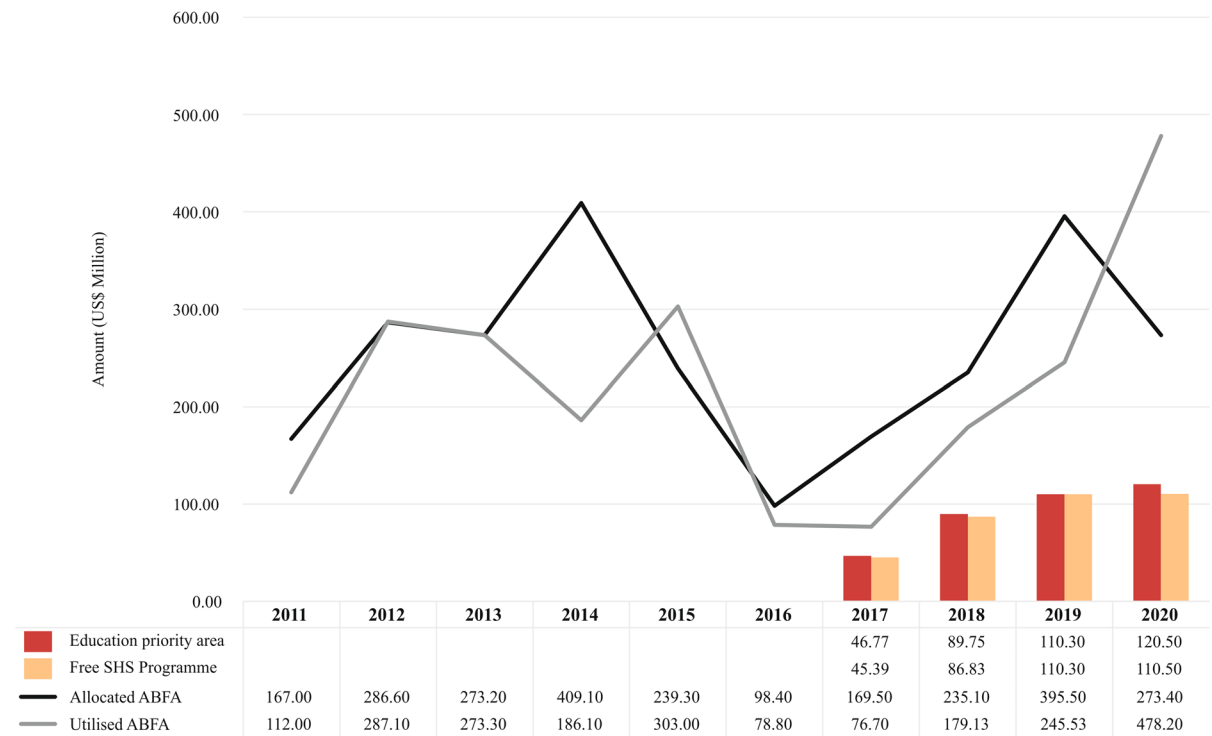
ordinary Ghanaians are least likely to get information on petroleum revenue in Ghana. Regarding accountability, in assessing the PIAC's works on petroleum revenue management, Graham et al. (2019) observed that there is a severe deficit in accountability. Their research revealed that the PIAC is ineffective in leading Ghanaians to demand accountability for petroleum revenue due to financial challenges. As Gyampo (2016) states, better transparency and accountability measures on petroleum revenue management are vital to prevent potential social conflict and the corrupt use of petroleum revenue by politicians in Ghana.

Ghanaians' engagement in petroleum revenue management

The accessible literature on Ghanaians' involvement in petroleum revenue management suggests that most Ghanaians are not informed and are unsatisfied with petroleum revenue management in Ghana. In their survey of 3526 Ghanaians, Brunnschweiler et al. (2021) observed that only 30.8% knew about petroleum revenue management in Ghana. Similarly, Ogbe et al. (2021) reported that about 45% of their survey participants did not know about petroleum revenue management in Ghana. Moreover, both studies indicate that most Ghanaians are not satisfied with petroleum management in Ghana. Ghanaians want to benefit from the petroleum revenue (Brunnschweiler et al., 2021). Specifically, they want to influence which projects the ABFA finances (Ogbe & Lujala, 2021).

Significance of the study

Previous research suggests that Ghanaians are not well-informed and happy about petroleum revenue utilization in Ghana. However, Ghanaians want to benefit from the revenue. Yet, there is a dearth of research regarding Ghanaians' sentiments about petroleum revenue management. So, this study surveyed the sentiments of Ghanaians about petroleum revenue management. This study is significant because it can help revenue managers to identify Ghanaians' grievances regarding petroleum revenue management and address them (the grievances) in time to avoid potential conflicts.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
■ Education priority area							46.77	89.75	110.30	120.50
■ Free SHS Programme							45.39	86.83	110.30	110.50
— Allocated ABFA	167.00	286.60	273.20	409.10	239.30	98.40	169.50	235.10	395.50	273.40
— Utilised ABFA	112.00	287.10	273.30	186.10	303.00	78.80	76.70	179.13	245.53	478.20

Fig. 1 The total ABFA allocation and utilisation, and the total expenditure on the education priority area and the Free SHS programme from 2017 to 2020. Data was from the Ministry of Finance' annual reports (2011–2021)

Conceptual review

Petroleum revenue management in Ghana

Ghana started managing its petroleum revenue in 2011 after enacting the Petroleum Revenue Management Act (PRMA). The PRMA created the Annual Budget Funding Amount (ABFA[1]) to finance national and community-based projects in Ghana (Stephens, 2019). At the end of 2020, as depicted in Fig. 1, the ABFA had received about US$2.5 billion from the petroleum revenue and financed projects to a total sum of about US$2.3 billion in Ghana (Ministry of Finance, 2018, 2019a, 2019b, 2020, 2021). Furthermore, the PRMA requires the Ministry of Finance and the Public Interest and Accountability Committee (PIAC) to inform Ghanaians and engage them for their opinions on the ABFA management. This

engagement is vital because research indicates that the opinions of citizens contribute to better natural resource revenue management in resource-rich countries (Birhan et al., 2021; Cumming et al., 2021; Lockwood et al., 2010; Lujala et al., 2020; Musavengane & Siakwah, 2020; Tantoh et al., 2021; Walden-Schreiner et al., 2018). Overall, the PRMA aims to help Ghana to avert the embedded resource curse (Bulte & Damania, 2008; Darby, 2010; Lujala & Rustad, 2012) within the petroleum sector.

The free senior high school programme

The Free SHS programme started in September 2017, and it covers all fees and expenses for all upper secondary school students, with boarding and meals (Cudjoe, 2018; Mohammed, 2020). The programme is under the Education priority area of ABFA funding. At the end of 2020, the Free SHS programme had received about 97% of ABFA funding in the Education priority area (see Fig. 1). This expenditure is enormous considering that, from the Ministry

---

[1] See Ogbe and Lujala (2021) and Stephens (2019) for more information about the ABFA.

of Finance reports (depicted in Fig. 1), it accounted for almost half of the total ABFA utilised within the same period (Ministry of Finance, 2018, 2019a, 2020, 2021).

Natural language processing

Natural language processing (NLP) refers to using computers to learn, understand, analyse, or produce texts in a human language, like English (Chowdhury, 2005; Eisenstein, 2019; Hirschberg & Manning, 2015; Jain et al., 2018; Nadkarni et al., 2011). NLP combines artificial intelligence and computational linguistics (Nadkarni et al., 2011) to make human and computer interaction efficient and easy (Jain et al., 2018). Thus, NLP includes an input (usually, a text), a task (to comprehend the content of a text), and an output (e.g., a database or summaries) (Jain et al., 2018; Nadkarni et al., 2011). NLP can help in work involving a large number of unstructured texts in emails, social media conversations, online chats, or survey responses. Regarding surveys, especially online surveys, NLP can be applied for opinion mining and sentiment analysis.

Methodological review

Opinion mining

Opinion mining is the method of extracting human thoughts and perceptions from unstructured texts (Hemmatian & Sohrabi, 2019). Specifically, it is a computational technique for extracting, classifying, understanding, and assessing public opinions (Bakshi et al., 2016; Chen & Zimbra, 2010). Since its inception in the early 2000s (Liu, 2012), as a subfield of natural language processing (Daud et al., 2017), opinion mining has helped researchers to examine and analyse people's opinions through their expressed comments within news, articles, and product and service reviews (Subrahmanian & Reforgiato, 2008). Opinion mining can help researchers to understand, analyse, and answer many geopolitical, social, and business-related research questions through comments expressed on social media (Chen & Zimbra, 2010). Within NLP, for comprehensive opinion mining, one needs to perform sentiment analysis.
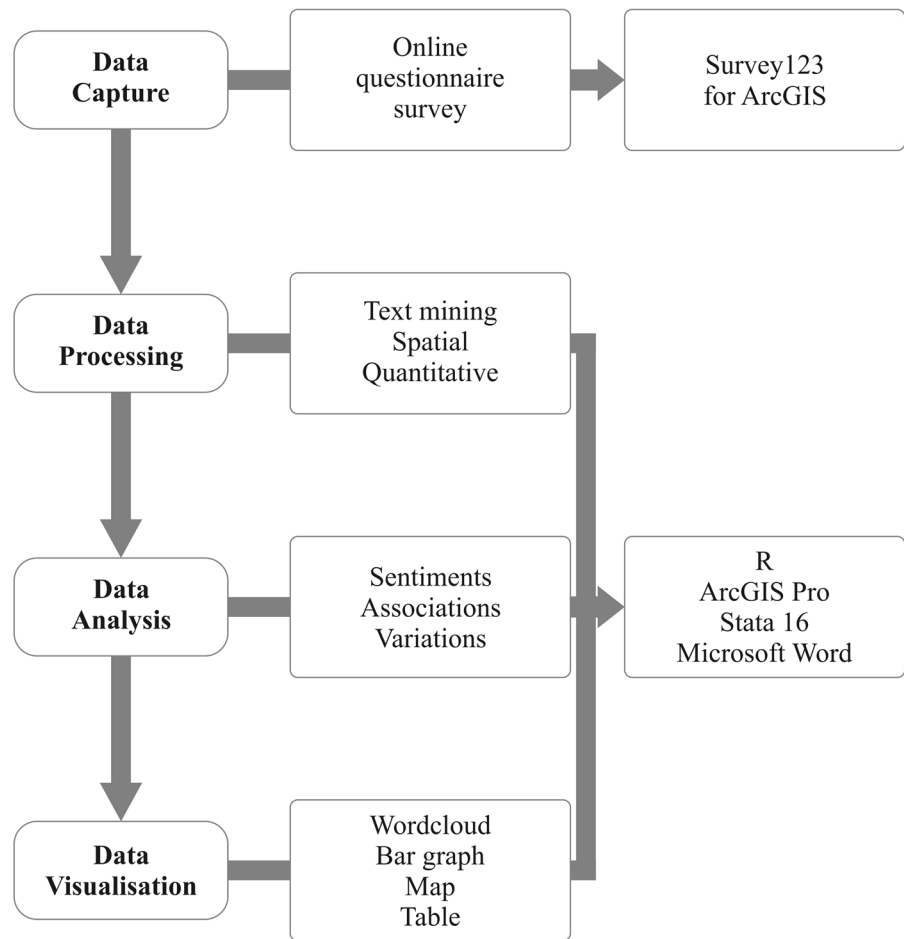
Sentiment analysis

Sentiment analysis is the process of identifying people's sentiments (negative, positive, or neutral), evaluations (trust or anticipation), and emotions (anger, fear, or joy) in a text document (Bakshi et al., 2016; Chen et al., 2019; Hemmatian & Sohrabi, 2019; Liu, 2012; Pang & Lee, 2008; Wilson et al., 2005). For large text documents, sentiment analysis can take place at three levels: document (Sharma et al., 2014; Xia et al., 2016), sentence (Hemmatian & Sohrabi, 2019; Yang & Cardie, 2014), and word (Chinsha & Joseph, 2015; Hussein, 2018). Document-level classifies the whole document as positive, negative, or neutral, while on the sentence and word levels, the classification is for each sentence or word, respectively. Sentiment analysis can use artificial intelligence methods such as machine learning (Habernal et al., 2014; Riaz et al., 2019), lexicon-based (Muhammad et al., 2016; Serrano-Guerrero et al., 2015), or hybrid methods (Abdul-Mageed et al., 2014; Keshavarz & Abadeh, 2017). This article used the lexicon-based method.

The lexicon-based method uses dictionaries that contain a broad collection of terms, phrases, and expressions to predict the overall sentiment of a piece of text (Muhammad et al., 2016; Serrano-Guerrero et al., 2015). For instance, whereas words such as "good" and "amazing" induce positive feelings in humans, "bad" and "scary" stimulate negative feelings (Liu, 2020). Lexicon-based sentiment analysis helps to find the polarity of each word in a text document. The analysis begins with the creation of a bag of words with their sentiment polarities, or the adoption of an existing one, from which the sentiment scores of terms are extracted, and it ends with predicting the sentiment of a given piece of text (Muhammad et al., 2016).

The use of sentiment analysis is dominant in business and political governance (Bakshi et al., 2016; Hemmatian & Sohrabi, 2019). In business and government intelligence, sentiment analysis mainly helps in reputation management and public relations (Shah & Patel, 2014). Using online feedback submissions or product reviews, e-commerce marketers can use sentiment analysis to identify their customers' expectations, evaluations, or

Fig. 2 Methodological
framework

grievances about their goods and services. Doing so helps in providing customer-tailored needs. Governments can use sentiment analysis to provide or improve services such as roads, hospitals, and leisure facilities, or to identify the public's evaluation of a new policy or reformation of an old one. Furthermore, political parties can use sentiment analysis to discern a public response to their campaign message for forthcoming elections (Akanksha & Sharma, 2018; Bakshi et al., 2016).

Nonetheless, it is difficult for sentiment analysis algorithms to recognise negated expressions, sarcasm and irony, multi-polarity, and exaggerations entirely accurately (Mohammad, 2017; Shayaa et al., 2018; Singhal et al., 2018). Thus, in a text document with

the mentioned elements, sentiment analysis may not accurately reveal the polarity, emotions, or evaluations of the commenters. However, coupled with intelligent data mining, visualization, and filtering methods, sentiment analysis can generate information of great utility to decision-makers for monitoring and rapid response purposes (Pozzi et al., 2017).

Method and data

As the study aimed at a large sample size within a short period, a quantitative methodology was adopted for data collection. For data assessments, various techniques of quantitative and sentiment analyses

were performed. Below is a brief account of the methodological workflow (see Fig. 2).

Data capture

The data were from an online survey among adult Ghanaians in Ghana between January and May 2020 through a spatial crowdsourcing platform. Following Ogbe and Lujala (2021), the study adopts Survey123 for ArcGIS to design the spatial crowdsourcing platform. Using a convenience sampling technique, five research assistants helped to share the survey link via social media (Facebook and WhatsApp) and Email for public participation. The target population was Ghanaians older than 17 years having GPS-incorporated and Internet-connected input devices. After receiving the link, the participants clicked it to access the survey, filled out the questionnaire, and submitted their responses. The research assistants used family and friends as contacts to recruit participants through WhatsApp from rural areas. It was easier to recruit urban participants because they were mostly online (for instance, on Facebook). All the participants were assured of their anonymity. The questions were about the participants' biographical data (e.g., age, gender, level of education) and their comments about the management of the petroleum revenue and the Free SHS programme (see Appendix for details). A participant could only respond once to the survey.

The total number of participants in the survey was 399, with 202 participants commenting on petroleum revenue management and the Free SHS programme. Based on Cochran (1963) equation,[2] the sample size is sufficient. Figure 3 indicates the location (with 100 m offset to secure privacy) where the participants completed the survey. The responses were stored in spreadsheet, text, and shapefile formats, which were processed, analysed, and visualised using R, ArcGIS Pro 2.7, StataMP 16, and Microsoft Word.

Data

The participants were averagely 31 years old, with a large majority (387) having received tertiary education. Most of them were men (269) and ordinary community members (196). Table 1 gives the summary statistics of the data. The comments about petroleum revenue management were, in total, 5342 words in 405 sentences with a maximum of 6 sentences and 52 words per participant. Conversely, the Free SHS programme comprised a total of 7908 words in 602 sentences, with a maximum of 7 sentences and 50 words per participant. Regarding petroleum revenue management, almost half of the participants (142) had negative sentiments, while for the Free SHS programme, the majority (208) had negative sentiments (see Fig. 4).
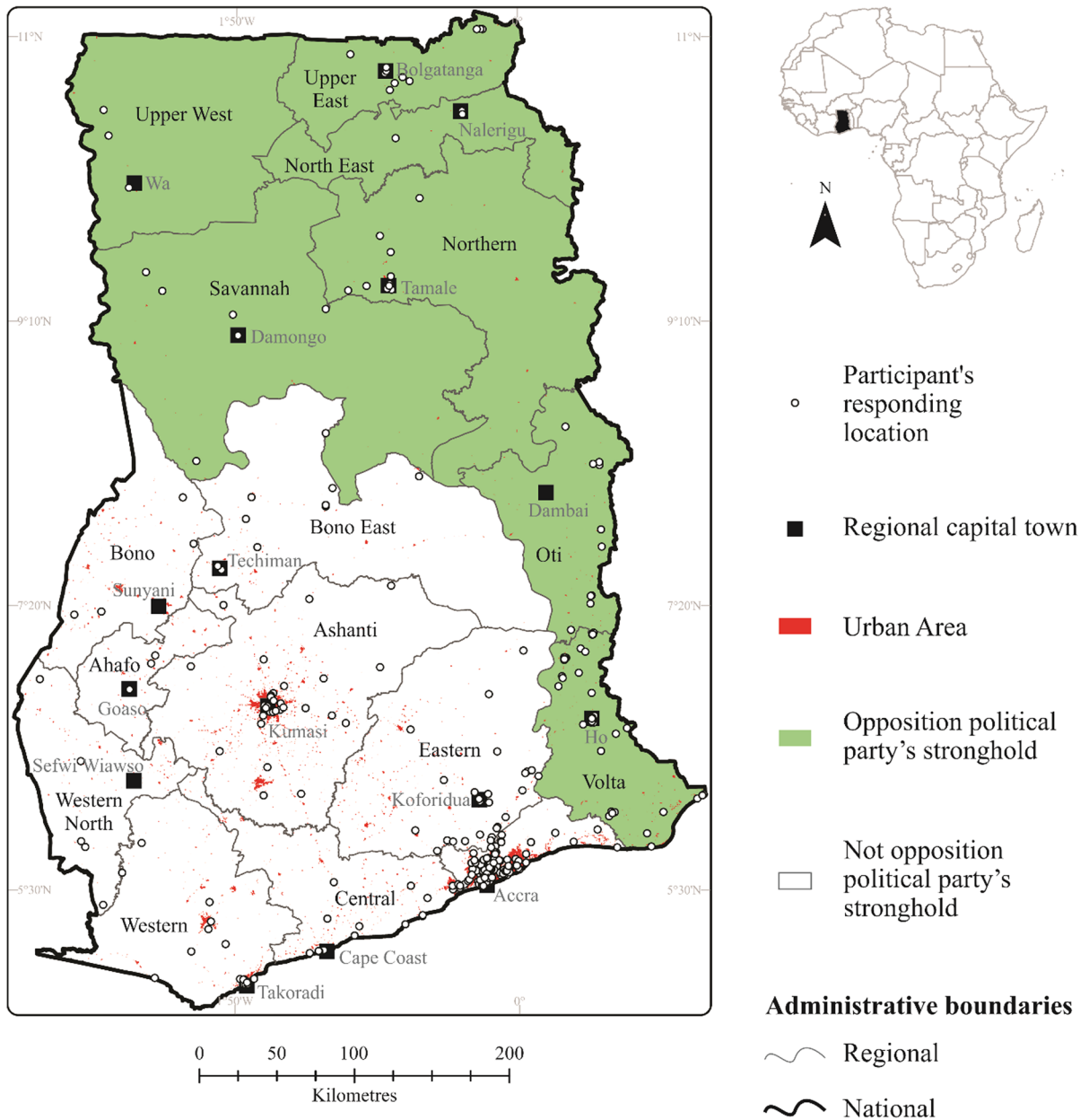
Response and explanatory variables

Two individual-level response variables are used in this article (Table 1). The explanatory variables are demographic and geographic:

1. *Demographic*: the participants had to input their age in numbers, choose their gender (male or female), their highest level of education achieved (options ranged from none to tertiary), and their position in the community (from an ordinary community member to a leadership position). Age, gender, education, and position in the community were coded by dummies taking the values of 1 if the participant is a youth,[3] female, tertiary educated, or an ordinary community member.[4] The participants also indicated their knowledge of available ABFA-funded project(s) in their areas. This variable was coded as a dummy with 1 as those who knew.

2. *Geographic*: To generate a dummy variable for the participants who were in a rural area (1) or urban (0), the study used the 2019 global Climate

---

[3] Between 18 and 35 years of age, according to Ghana Statistical Service (2019).

[4] An ordinary community refers to a citizen who has no leadership position.

---

[2] Using Cochran's equation: $n_o = \frac{Z^2 * \sigma(1-\sigma)}{e^2}$ where n_o = required sample size, Z = confidence level (95%), σ = standard deviation (0.5), and e = margin of error (±5%). Substituting the values into the equation respectively, the n_o would be 385.

Fig. 3 Location of the survey participants, the opposition political party's strongholds, and urban areas

Change Initiative Landcover from the European Space Agency dataset.[5] Moreover, the distances from where the participants answered the survey to the nearest regional capital town and urban area were calculated from the administrative regional capital towns and the urban area data. Lastly, a different dummy variable for the participants in the opposition political party's stronghold (1) or not (0) was generated.

---

[5] The 2019 dataset was the most current at the time. For details, see ESA (2020).

**Table 1** Summary statistics for the variables

Variable	Obs	Median	Inter quartile range	Min	Max	Coding
Response						
Sentiment about petroleum revenue management (RV1)	306					1 = Negative (46%) 2 = Neutral (52%) 3 = Positive (2%)
Sentiment about the management of the Free SHS programme (RV2)	385					1 = Negative (54%) 2 = Neutral (29%) 3 = Positive (17%)
Explanatory						
Age	399					Dummy: 1 = youth participant (79%)
Gender	399					Dummy: 1 = female (32%)
Educational level	399					Dummy: 1 = at least tertiary education (97%)
Position in the community	399					Dummy: 1 = no leadership or privileged position in the community (49%)
Existing ABFA project	399					Dummy: 1 = knowing of an existing ABFA-funded project in the community (30%)
Rural Area	399					Dummy: 1 = residing in a rural area (30%)
Distance to nearest regional capital	399	17	33.2	0	123	Distance (km) from the participants response location to the nearest regional capital
Distance to nearest urban area	399	0	0.9	0	63.1	Distance (km) from the participants response location to the nearest urban area
Opposition stronghold	399					Dummy: 1 = residing in a stronghold of the opposition political party (27%)

Sources: the rural area data was from ESA (2020) and the opposition stronghold data was from Osei (2013) and Asante and Gyimah-Boadi (2004)

Hypotheses

The hypotheses in this article are informed by previous research. The more informed citizens are, the less negative they will be about natural resource revenue management (Le Billon, 2007, 2010; Lujala, 2017; Lujala et al., 2020; Musavengane & Siakwah, 2020; Orogun, 2010). Overall, men, the youth, and the more educated seem to be more informed on national issues than women, the aged, and the less educated (Bernal & Vásquez, 2016; Lujala et al., 2020; Ogbe et al., 2021). Nonetheless, urban dwellers tend to be more informed than rural folks (Garcia-Cosavalente et al., 2010; Ofori & Lujala, 2015; Ogbe et al., 2021). Additionally, in the Ghanaian context, as the PIAC engages more local

leaders and communities with ABFA-funded projects, they (leaders and ABFA-funded community members) may be more informed than the non-leaders and community members without ABFA-funded projects regarding petroleum revenue management. Finally, the study hypothesised that as the implementation of the Free SHS programme excluded political consensus (Cudjoe, 2018; Mohammed & Kuyini, 2021), the sentiment about the Free SHS programme will vary contingent on which political party dominates in the participant's location. Thus, the participants in the strongholds of the governing party, the New Patriotic Party (NPP) will likely be more positive than those in the opposition party, the National Democratic Congress (NDC). The four hypotheses are summarised as follows:

Petroleum revenue management
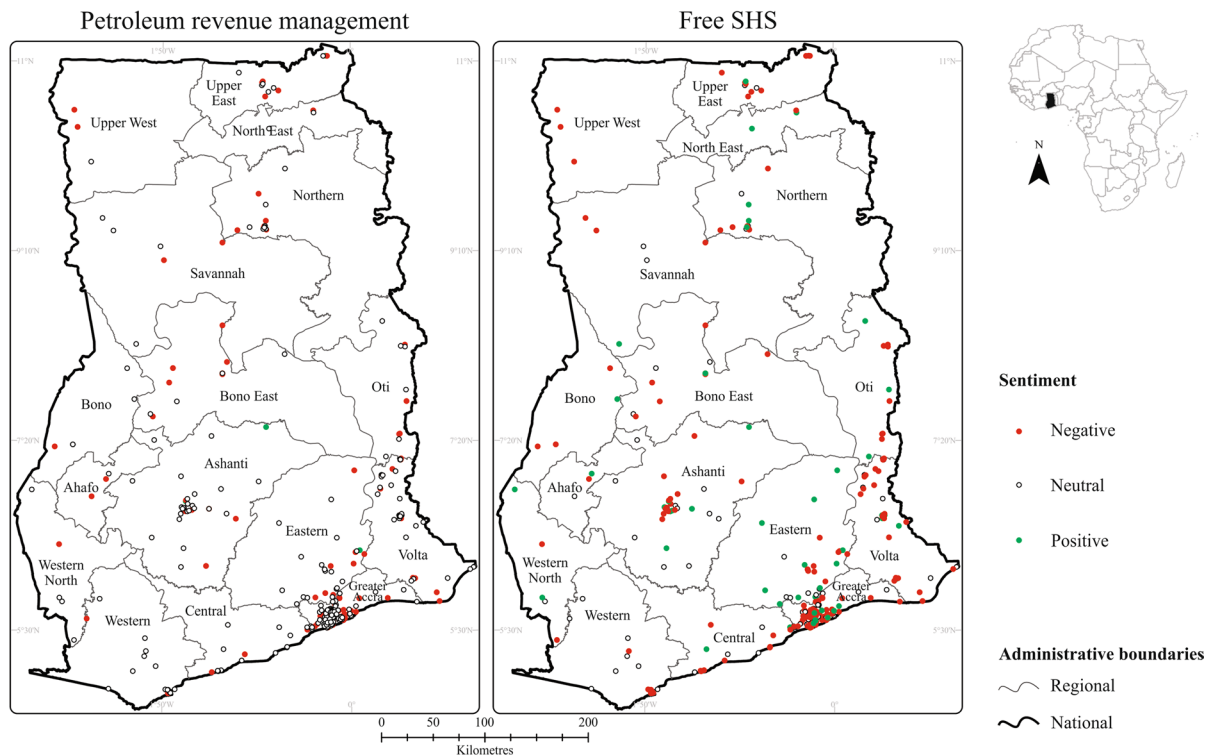
Free SHS

Fig. 4 Geographic distribution of the study participants' sentiments concerning the management of the petroleum revenue and the Free SHS programme at the regional level. Note: The polarity represents sentence-level sentiment analyses

H1: Ghanaian women are likely to have negative sentiments about petroleum revenue management and the Free SHS programme in Ghana.

H2: Ghanaians without leadership or privileged positions in their communities are likely to have negative sentiments about petroleum revenue management and the Free SHS programme in Ghana.

H3: Ghanaians who know about an existing ABFA-funded project are likely to have positive sentiments about the petroleum revenue management and the Free SHS programme in Ghana.
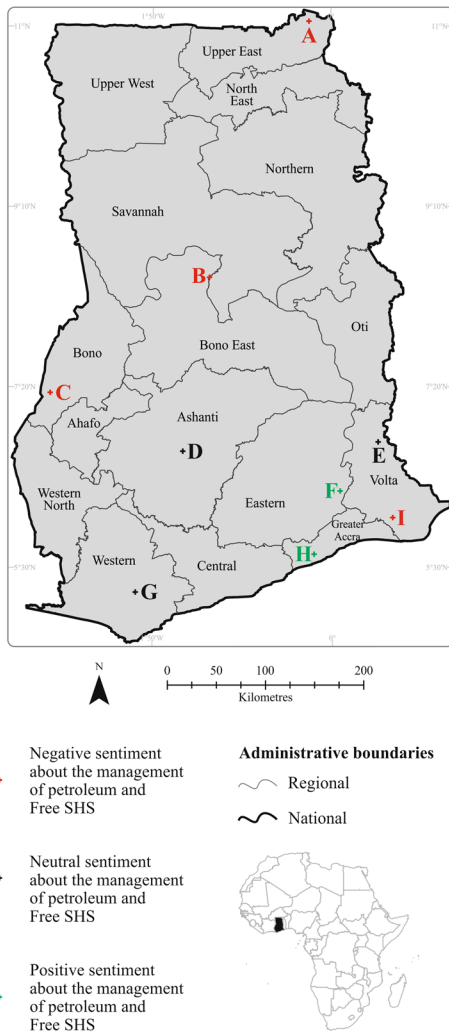
H4: Ghanaians in the strongholds of the opposition political party (the NDC) are likely to have negative sentiments about the Free SHS programme in Ghana.

Data processing, analyses, and visualisation

The main data processing was *text mining* in R. First, the participants that commented on the petroleum revenue were sorted out and saved separately in an excel file. The same process was repeated

for the comments about the Free SHS programme too. Afterward, using the 'corpus' function from the 'tm' package from Feinerer (2013), the comments were tokenised into individual words. Next, using the '*tm_map*' function from the same package, the tokens were cleaned by removing numbers, stop words (i.e., the most common words, such as 'is', 'be', 'to' that do not have any sentiments on their own), punctuations, and extra white spaces. Further, a term-document matrix and a data frame were created for the cleaned datasets. Thereafter, the cleaned datasets were resaved as new comma-separated values (.csv) files and all the words (i.e., words like 'educate', 'educating', 'educated', and 'education' categorised as 'education') were manually stemmed. Finally, the stemmed words were saved in an excel file.

To analyse the participants' comments regarding the management of petroleum revenue and the Free SHS programme, the study used sentence-level sentiment analysis (Hemmatian & Sohrabi, 2019; Wilson et al., 2005) in R to identify their emotions and

Participant 782: 35 years old man.
A **Free SHS:** *The implementation is not done well, and the grade's that are been admitted into the (shs) schools will lower the standards of our education in future.*
Petroleum: *There is abuse and misappropriation of the oil revenue.*

Participant 673: 35 years old man.
Fress SHS: *There is too much in efficiencies in the system such as; 1. The double track is not offering both teachers and students enough teaching and learning time. 2. Delay in the release*
B *of funds to schools which often put school heads into unpleasant situations.*
Petroleum: *The use of the legacy fund for free shs is a violation of the policy.*

Participant 582: 23 years old man.
C **Free SHS:** *It is very annoying.*
Petroleum: *Should be used appropriately and not left at the mercies of our hungry politicians.*

Participant 124: 32 years old man.
Free SHS: *It shouldn't be totally free parents should help the policy by paying something small*
D *to help build school infrastructure, it's free we are seeing more students but no classroom and government is sacrificing other important things like roads and health.*
Petroleum: *None*

Participant 474: 25 years old man.
Free SHS: *I think there should be a quota for the admission. More dormitories should be built and the free shs should be a gradual process.*
E **Petroleum:** *The percentage of the portion of the oil given to Ghana is too small which should be looked at. The oil revenue should also be used for construction of roads, scholarship for brilliant students, subsidising fuel prices and acquiring of educational material.*

Participant 712: 28 years old man.
F **Free SHS:** *It's a very good policy just that the Gold and Green shift tracks should be refined.*
Petroleum: *The government is doing well.*

Participant 702: 32 years old man.
Free SHS: *There is the need to embark on heavy infrastructure development across the country in the field of education and accessible road.*
G **Petroleum:** *Mostly oil revenue should be invested in areas which yield better result in the future so that if possibly when the reserve goes down, future generation can also benefit such as agricultural industries, education, road, tourism.*

Participant 56: 19 years old woman.
H **Free SHS:** *It's good in terms of those in poverty.*
Petroleum: *It's good.*

Participant 685: 30 years old man.
Free SHS: *The double track system has a number of challenges. Students in both tracks do not have enough study and teaching hours. Inadequate Infrastructure projects is a huge problem*
I *for students. Over crowding of students still a problem irrespective of the double track system.*
Petroleum: *Communities where high value resources like oil, gold, diamond etc. are mined or explored are unfortunately undermined in terms of development projects in Ghana. These communities have poor road, no proper medical facilities and no significant contribution.*

Fig. 5 Location of sample comments and the participants' sentiments

sentiments. The emotions analysis generated 8 new columns (Figs. 7 and 9), and the sentiments, 3 columns (Figs. 4 and 5) for each participant. The new columns were appended to the spatial attribute table for extra analyses in Stata and ArcGIS Pro. Additionally, to get the sentiments of the words in the participants' comments, the sentiment polarity in the stemmed words on a word-level (Chen et al., 2019; Li et al., 2017) was analysed using the 'sentiment' package (Figs. 6 and 8).

Furthermore, from simple tabulations, crosstabulations, and regression analyses, statistical inferences and observations were made regarding the response variables. To determine the frequencies of the

sentiment polarities about the response variables at the regional level, the 'select by attributes' and 'select by location' tools in ArcGIS Pro (Table 2) were used. Additionally, an ordered logistic regression was run to investigate how the response variables relate to the explanatory ones (Table 3). To account for unobserved heterogeneities in the models due to geography/proximity, fixed effects on the *region* and cluster-adjusted *district*[6] were included for any within-cluster correlation or heteroscedasticity as recommended by Cameron and Miller (2015). Due to the low number

---

[6] There are 260 districts (the second-level administrative area) in Ghana.

Fig. 6 Repeated words in the study participants' comments about petroleum revenue. Notes: Positive and negative words are in green and red colours, respectively (A), and words appearing at least twice in the comments are shown in (B)

Table 2 Study participants' combined sentiments about the management of petroleum revenue and the Free SHS programme at regional level

Region	Both negative (−)	Both neutral	Both positive (+)	Only petroleum (−)	Only free SHS (−)	Only free SHS (+)	Petroleum (−) and free SHS (+)	Petroleum (+) and free SHS (−)	Total
Ahafo	1			1		1			3
Ashanti	4	10	2	2	10	4	1		33
Bono	1	1			2	1			5
Bono East	4	2		2	2		1		11
Central	1	3		2	9	2			17
Eastern	3	4	1	2	7	7	3		27
Greater Accra	41	40	1	21	47	17	7		174
North East	1					2			3
Northern	4	4		1	3	1	2		15
Oti	4				3	3			10
Savannah	2	1		1	2	1			7
Upper East	4	2			4		1	1	12
Upper West	2				1				3
Volta	17	14		2	18	6			57
Western	2	8		1	6				17
Western North	1	1			1	2			5
TOTAL	92	90	4	35	115	47	15	1	399

of participants, none of the spatial analyses (i.e. hot-spots) yielded meaningful results, and therefore they were ignored. Finally, the results from the analyses were visualised using either wordcloud, bar graph, map, or table as applicable.

Table 3 Study participants' sentiments about the management of petroleum revenue and the Free SHS programme

	Petroleum revenue management	Free SHS
Youth	−0.06 (0.26)	−0.1 (0.28)
Woman	0.44* (0.26)	−0.01 (0.21)
Tertiary educated	−0.71 (0.74)	−0.53 (0.61)
No position in the community	−0.12 (0.21)	−0.19 (0.21)
Existing ABFA project	−0.49* (0.25)	−0.32 (0.26)
Opposition stronghold	1.3 (1.07)	−1.18*** (0.46)
Rural Area	−0.23 (0.37)	0.08 (0.37)
Closeness to nearest regional capital	−0.00 (0.01)	0.00 (0.01)
Closeness to nearest urban area	0.01 (0.02)	−0.00 (0.02)
Observations	306	385

Ordered Logistic Regression models with Robust Standard Error in parentheses. The Table shows the odds ratio for the coefficient: $*p < 0.1$ and $***p < 0.01$

Empirical limitation

Spatial crowdsourcing projects are likely to be unrepresentative and biased (Bubalo et al., 2019; Ogbe & Lujala, 2021). The data in this article are biased towards tertiary-educated Ghanaians because less than 10% of Ghanaians had this level of education in 2017 (Ghana Statistical Service, 2019). Comparatively, the study participants might have been more highly educated (and wealthier) and therefore they possessed the required technology and skills (e.g. an ability to read and write English), saw information about the survey, got interested, and more of them participated. However, the aim of the survey was to extract Ghanaians' sentiments about petroleum revenue management, not decisions about upcoming petroleum revenue-funded projects, as scholars like Güiza and Stuart (2018), Ofori and Lujala (2015), and Ogbe and Lujala (2021) argue that the resulting unrepresentativeness could be an issue. So, from the objective, as Czepkiewicz et al. (2017) contend, the unrepresentativeness of the sample is, considerably, unimportant.

Results and discussion

Generally, the participants were not positive about petroleum revenue management and the Free SHS programme. From Table 2, it can be observed that while 23% of the participants had negative sentiments, only 1% were positive regarding both the abovementioned types of management. The following subsections present the specifics of each management type.

Fig. 7 Count of words associated with each emotion in the study participants' comments about petroleum revenue management
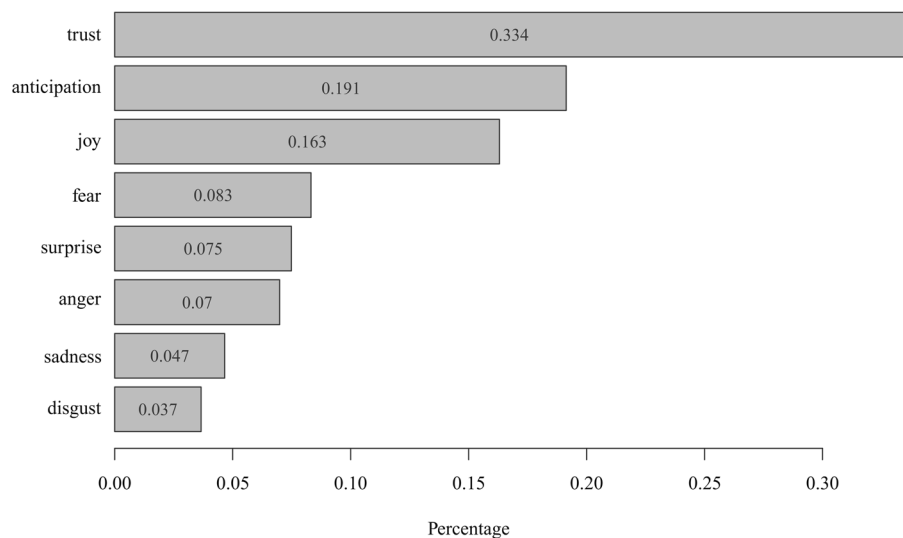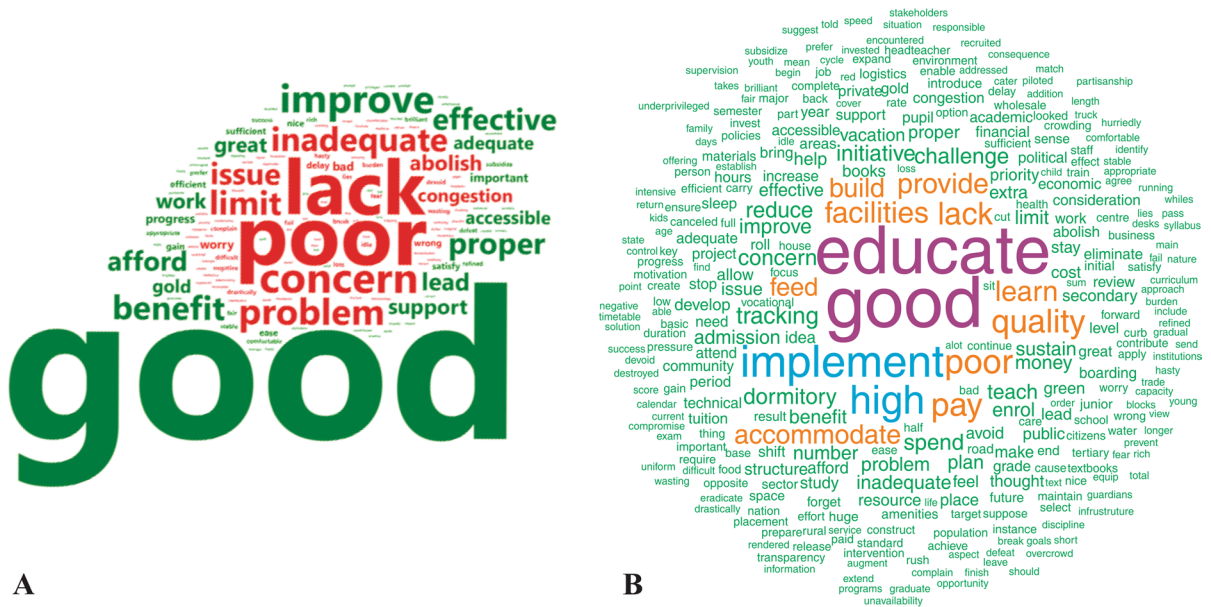
Fig. 8 Repeated words in the comments about the Free SHS programme. Notes: Positive and negative words are shown in green and red, respectively (A), and words appearing at least twice in the comments are shown in (B)

Fig. 9 Count of words associated with each emotion in the comments about the management of the Free SHS programme
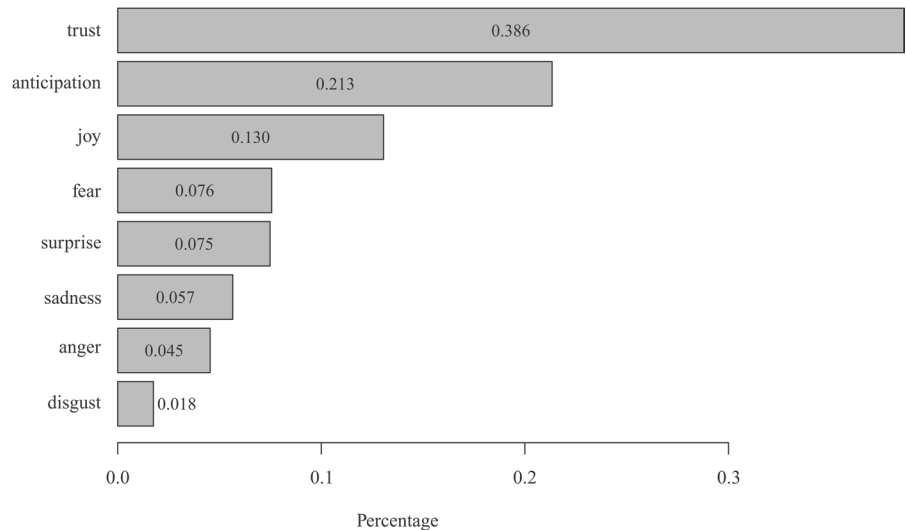
Sentiments about petroleum revenue management

Largely, the sentence-level sentiment analysis indicates that the participants were not positive about petroleum revenue management in the country (Table 2 and Fig. 4). However, on the word-level

sentiment analysis (Fig. 6A), out of the 96 repeated sentiment words in the participants' comments, 51 of them were positive, with "benefit" as the most repeated positive word (32 times). Contrarily, the most negative word (poor) appeared four times fewer than the most positive word. Figure 7 indicates that

the positive emotions of "trust" and "joy" account for almost half of the meaningful words in the comments about petroleum revenue management. Conversely, the negative emotions of "disgust", "sadness", "anger", and "fear" constituted about 24% of the meaningful words.

Regarding the hypotheses, the analyses confirmed none. For instance, the results proved the opposite of hypotheses 1 and 3 about being a woman and knowing about an existing ABFA-funded project (the second column in Table 2). That is, women were likely to be 0.44 levels up (more positive), and those who knew about any ABFA-funded project in their area were 0.49 levels down (more negative). Women seem to have a positive sentiment towards the Free SHS programme probably because the programme allows more girls (who could not have afforded secondary education) to be in school and as Kwegyiriba (2021) indicates, education limits teenage girls' exposure to pregnancy. However, Ogbe et al. (2021) observed that Ghanaians who know a petroleum revenue-funded project are likely to be informed about the general petroleum revenue management in Ghana. More so, the Free SHS programme has increased student enrolment to the detriment of adequate teaching staff, learning materials, and school infrastructure (Chanimbe & Dankwah, 2021; Matey, 2020). Hence, those who knew about existing project in their area could also have been aware of the challenges of the Free SHS programme, consequently, their negative sentiment.

The results in this section closely reflect that of Armah-Attoh (2015), Abraham (2019), Stephens (2019), and Brunnschweiler et al. (2021). Armah-Attoh (2015) and Brunnschweiler et al. (2021) observed that most Ghanaians are not satisfied with petroleum revenue management in the country. Besides, they indicate that most Ghanaians want the government to be more transparent and accountable to them regarding revenue management. Noticeable from the participants' comments, among the top 10 most used words, were "accountability" and "transparency" occurring 27 and 25 times, respectively (Fig. 6B). Additionally, in common with findings reported by Armah-Attoh (2015) and Stephens (2019), some participants (see comment G in Fig. 5) suggested the Government should use the revenue for development projects that would benefit more Ghanaians across space and time. Thus, the participants

seemed to trust the management probably because they anticipate that the Government could manage the petroleum revenue better and would become more accountable and transparent to them. Trust is vital in petroleum revenue management as it is a necessity for effective accountability in natural resource management (Musavengane & Siakwah, 2020).

In general, the study results are significant for petroleum revenue managers in two ways. First, the PIAC and the Government could use sentiment analysis to examine the opinions of citizens regarding petroleum revenue management. For instance, in Ghana, the PIAC can analyse Ghanaians' sentiments about the ABFA's utilisation in the country. Furthermore, although not covered in this article, they could identify which areas of Ghana are citizens more negative toward revenue management and engage them regarding their grievances. Secondly, the PIAC and the Government could combine spatial crowdsourcing and natural language processing for efficient allocation of petroleum revenue for projects in the future. For instance, they could identify the most prioritised project(s) for each area through an opinion survey in the country.

Sentiments about the management of the Free SHS programme

From the sentence-level sentiment analysis, it was evident that most of the participants were negative about the management of the Free SHS programme in Ghana (Table 2 and Fig. 4). Moreover, the word-level sentiment analysis (Fig. 8A) revealed that out of the 150 repeated sentiment words in the participants' comments, 80 were negative, with "poor" as the most repeated negative word (28 times). Conversely, the most positive word ("good") appeared 69 times. However, the positive emotions of "trust" and "joy" accounted for almost 52% of the meaningful words in the comments about the Free SHS programme (Fig. 9). Moreover, the negative emotions of "disgust", "sadness", "anger", and "fear" constituted about 20% of the meaningful words. Thus, even though the participants were more negative about the Free SHS programme, they trusted the management and anticipate it would become better, even more than the management of the petroleum revenue in general.

The results support the fourth hypothesis. The participants in the stronghold of the opposition political

party (the NDC) were likely to be negative about the Free SHS programme (the third column in Table 2). This could be a consequence of excluding some stakeholders, for instance, parents and other political parties from the planning and implementation (Gbadago, 2020; Mohammed & Kuyini, 2021) of the Free SHS programme. Furthermore, the programme has some notable challenges (mentioned earlier) and has contributed to poor academic performance from the beneficiaries (Takyi et al., 2019). The participants might have experienced some of these challenges, in which case the experience might have led to their negative sentiments.

Overall, the results indicate that the Government needs broader consultation for the sustainability of the programme. Additionally, as "lack", "facilities", "provide", and "build" were among the top 15 most repeated words (more than 20 times) in the comments about the Free SHS programme (Fig. 8B), the Government should consider providing adequate infrastructure across the schools.

Conclusion

Analysing public sentiments regarding policies or services can help governments or decision-makers to provide better services. This article analyses the sentiments of Ghanaians, surveyed from a spatially crowdsourced platform on petroleum revenue and the Free Senior High School programme management in Ghana. The results suggest that, largely, the participants were not positive about the petroleum revenue and the management of the Free SHS programme. But they showed trust in the managers and anticipated better management in the future. Regarding the Free SHS programme, the government needs broader consultation with all stakeholders, especially parents of the students and the opposition political parties to sustain it. The findings imply that the Ghanaian government needs to involve all stakeholders in deciding on petroleum revenue utilisation in Ghana. Overall, as this study did not probe the sentiments of Ghanaians, further studies could investigate why Ghanaians have

negative sentiments regarding petroleum revenue management.

Availability of data and materials   The datasets generated and/or analysed during the study are available in EUDAT repository (http://doi.org/10.23728/b2share.f73b6133efd84e0ea632dc722891971f).

Code availability   The Stata and R analyses' codes are in the same data repository.

Declarations

Conflict of interest   None.

Consent to participate   The participants in this research gave their consents.

Consent for publication   The participants in this research consented to the publication of their responses.

Ethics approval   NSD—Norwegian centre for research data approved this research (reference number—973892).

Appendix

Survey questions with response alternatives and frequencies

Note: All response alternatives included the options 'Do not know' and 'Do not want to answer'.

1. What is your age?
(Numbers only)
2. Please choose your gender.
Male (269)
Female (129)
Do not want to answer (1)
3. What is your highest level of education?
None (0)
Primary School (0)
Junior High School (1)
Middle School (0)
Secondary/Technical School (7)
Tertiary (387)
4. Which of the following best describes your position in your community?
Ordinary community member (196)
Paramount chief (1)
Chief (0)
Queen mother (0)
Chief's wife (0)
Unit Committee member (0)
Area Assembly member (1)
Youth leader (34)
Women's leader (3)
Religious leader (13)
Tribal (ethnic) leader (0)
Teacher (49)
Opinion leader (21)
Other (40)
5. Please choose your home region (the region you come from).
Ahafo (3)
Ashanti (50)
Bono (2)
Bono East (4)
Central (25)
Eastern (29)
Greater Accra (70)
North East (2)
Northern (4)
Oti (18)
Savannah (4)
Upper East (23)
Upper West (8)
Volta (128)
Western (18)
6. Kindly comment on the general use of petroleum revenue in Ghana.
Comments (306)
7. Kindly comment on the Free SHS programme in Ghana.
Comments (385)

References

Abdul-Mageed, M., Diab, M., & Kübler, S. (2014). SAMAR: Subjectivity and sentiment analysis for Arabic social media. *Computer Speech & Language, 28*(1), 20–37. https://doi.org/10.1016/j.csl.2013.03.001

Abdul-Rahaman, N., Rahaman, A. B. A., Ming, W., Ahmed, A.-R., & Salma, A.-R.S. (2018). The free senior high policy: An appropriate replacement to the progressive free senior high policy. *International Journal of Education and Literacy Studies, 6*(2), 26–33. https://doi.org/10.7575/aiac.ijels.v.6n.2p.26

Abraham, K. K. A. (2019). Petroleum revenue management in Ghana: The epoch of high expectation in perspective. *Journal of Sustainable Development Law and Policy, 10*(1), 32–55.

Adarkwah, M. A. (2022). Anatomy of the "free senior high school" policy in Ghana and policy prescriptions. *Interchange.* https://doi.org/10.1007/s10780-022-09459-3

Adu-Gyamfi, S., Marfo, C. O., Nyaaba, A. Y., Amakye-Boateng, K., Abass, M., & Yartey, H. T. (2020). Free senior high school (SHS) and quality university education in Ghana: The role of the university teacher. *Journal of Educational and Social Research, 10*(5), 225–225. https://doi.org/10.36941/jesr-2020-0101

Akanksha, M., & Sharma, S. K. (2018). Sentimental analysis: A survey. *International Journal of Computer Sciences and Engineering, 6*(7), 939–951. https://doi.org/10.26438/ijcse/v6i7.939951

Armah-Attoh, D. (2015). Ghana's oil revenue management: Convergence of popular opinion, the law, and practice. *Afrobarometer Policy Paper*, *No. 19*. http://afrobarometer.org/sites/default/files/publications/Policy%20papers/ab_r6_policypaperno19.pdf

Asante, R., & Gyimah-Boadi, E. (2004). *Ethnic structure, inequality and governance of the public sector in Ghana* (Governance (2000–2009)). https://cdn.unrisd.org/assets/library/papers/pdf-files/asante-ssmall.pdf

Bakshi, R. K., Kaur, N., Kaur, R., & Kaur, G. (2016). Opinion mining and sentiment analysis. In *2016 3rd international conference on computing for sustainable global development (INDIACom)*, https://ieeexplore.ieee.org/abstract/document/7724305/metrics#metrics

Bernal, A. T., & Vásquez, W. F. (2016). Information sources and profile of informed citizens: An empirical analysis from Guatemala. *Information Development, 32*(3), 709–717. https://doi.org/10.1177/0266666914568575

Birhan, E., Assefa, E., & Petrova, M. A. (2021). Determinants of good forest governance in Southeastern Ethiopia: The case of the bale eco-region. *GeoJournal*. https://doi.org/10.1007/s10708-021-10415-4

Brunnschweiler, C., Edjekumhene, I., & Lujala, P. (2021). Does information matter? Transparency and demand for accountability in Ghana's natural resource revenue management. *Ecological Economics, 181*, 106903. https://doi.org/10.1016/j.ecolecon.2020.106903

Bubalo, M., van Zanten, B. T., & Verburg, P. H. (2019). Crowdsourcing geo-information on landscape perceptions and preferences: A review. *Landscape and Urban Planning, 184*, 101–111. https://doi.org/10.1016/j.landurbplan.2019.01.001

Bulte, E., & Damania, R. (2008). Resources for sale: Corruption, democracy and the natural resource curse. *The BE Journal of Economic Analysis & Policy*. https://doi.org/10.2202/1935-1682.1890

Cameron, A. C., & Miller, D. L. (2015). A Practitioner's guide to cluster-robust inference. *Journal of Human Resources, 50*(2), 317–372. https://doi.org/10.3368/jhr.50.2.317

Chanimbe, T., & Dankwah, K. O. (2021). The 'New' Free Senior High School Policy in Ghana: Emergent issues and challenges of implementation in schools. *Interchange, 52*, 599–630. https://doi.org/10.1007/s10780-021-09440-6

Chen, H., & Zimbra, D. (2010). AI and opinion mining. *IEEE Intelligent Systems, 25*(3), 74–80. https://doi.org/10.1109/MIS.2010.75

Chen, R., Zhou, Y., Zhang, L., & Duan, X. (2019). Word-level sentiment analysis with reinforcement learning. *IOP Conference Series: Materials Science and Engineering*. https://doi.org/10.1088/1757-899X/490/6/062063

Chinsha, T. C., & Joseph, S. (2015). A syntactic approach for aspect based opinion mining. In *Proceedings of the 2015 IEEE 9th international conference on semantic computing (IEEE ICSC 2015)*, doi:https://doi.org/10.1109/ICOSC.2015.7050774

Chowdhury, G. G. (2005). Natural language processing. *Annual Review of Information Science and Technology, 37*(1), 51–89. https://doi.org/10.1002/aris.1440370103

Cochran, W. G. (1963). *Sampling techniques* (2 ed.). Wiley.

Cudjoe, F. (2018). *Speaking notes on "Free Senior High School education in Ghana: prospects, challenges and recommendations* (Occasion of the 8th Graduation and the 9th Matriculation Ceremonies of Knutsford University College, East Legon, November). https://imaniafrica.org/2018/11/26/speaking-notes-on-free-senior-high-school-education-in-ghana-prospects-challenges-and-recommendations/

Cumming, G., Campbell, L., Norwood, C., Ranger, S., Richardson, P., & Sanghera, A. (2021). Putting stakeholder engagement in its place: How situating public participation in community improves natural resource management outcomes. *GeoJournal*. https://doi.org/10.1007/s10708-020-10367-1

Czepkiewicz, M., Jankowski, P., & Mlodkowski, M. (2017). Geo-questionnaires in urban planning: Recruitment methods, participant engagement, and data quality. *Cartography and Geographic Information Science, 44*(6), 551–567. https://doi.org/10.1080/15230406.2016.1230520

Darby, S. (2010). *Natural resource governance: New frontiers in transparency and accountability* (S.E.B. Strategy Report). O. S. Foundation. http://www.transparency-initiative.org/archive/wp-content/uploads/2011/05/natural_resources_final1.pdf

Daud, A., Khan, W., & Che, D. (2017). Urdu language processing: A survey. *Artificial Intelligence Review, 47*, 279–311. https://doi.org/10.1007/s10462-016-9482-x

Eisenstein, J. (2019). *Introduction to natural language processing*. The MIT Press.

ESA. (2020). *Land Cover CCI Product User Guide Version 2.0.* https://maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf

Feinerer, I. (2013). Introduction to the tm package text mining in R. Accessible en ligne: http://cran.r-project.org/web/packages/tm/vignettes/tm.pdf.

Garcia-Cosavalente, P. H., Wood, L. E., & Obregon, R. (2010). Health information seeking behavior among rural and urban Peruvians: Variations in information resource access and preferences. *Information Development, 26*(1), 37–45. https://doi.org/10.1177/0266666909358640

Gbadago, F. (2020). *Participatory communication for community development: the Ghanaian experience* (Publication Number Manchester, UK) University of Salford]. http://usir.salford.ac.uk/id/eprint/58309

Ghana Statistical Service. (2019). *Ghana Living Standards Survey round seven (GLSS) 7*. G. S. Service. https://open.africa/organization/about/ghana-statistical-service

Ghose, J., Bakshi, S. K., Arora, N., Sharma, R., Deepa, N., & Govindan, M. (2018). *Natural resource revenue management in low and middle-income countries experiencing politically fragile conditions: A systematic review. contextualisation of review findings for Afghanistan and Myanmar*. EPPI-Centre. https://assets.publishing.service.gov.uk/media/5b101fb240f0b634b73dbe30/Contextualization_Document_final.pdf

Graham, E., Gyampo, R. E. V., Ackah, I., & Andrews, N. (2019). An institutional assessment of the public interest and accountability committee (PIAC) in Ghana's oil and gas sector. *Journal of Contemporary African Studies, 37*(4), 316–334. https://doi.org/10.1080/02589001.2020.1715929

Gudynas, E. (2016). Natural resource nationalisms and the Compensatory State in progressive South America. In P. A. Haslam & P. Heidrich (Eds.), *The political economy of natural resources and development: From neoliberalism to resource nationalism* (pp. 125–140). Routledge. https://books.google.no/books?hl=en&lr=&id=_2WFCwAAQBAJ&oi=fnd&pg=PA103&dq=citizens+sentiments+on+natural+resource+revenue+management&ots=0s4vVj4wbx&sig=Q2NGGwo8pkEKx5oR12LwExOoLXw&redir_esc=y#v=onepage&q&f=false

Güiza, F., & Stuart, N. (2018). When citizens choose not to participate in volunteering geographic information

to e-governance: A case study from Mexico. *GeoJournal, 83*(5), 1151–1167. https://doi.org/10.1007/s10708-017-9820-9

Gyampo, R. E. V. (2016). Transparency and accountability in the management of oil revenues in Ghana. *Africa Spectrum, 51*(2), 79–91. https://doi.org/10.1177/000203971605100205

Habernal, I., Ptáček, T., & Steinberger, J. (2014). Supervised sentiment analysis in Czech social media. *Information Processing & Management, 50*(5), 693–707. https://doi.org/10.1016/j.ipm.2014.05.001

Hemmatian, F., & Sohrabi, M. K. (2019). A survey on classification techniques for opinion mining and sentiment analysis. *Artificial Intelligence Review, 52*(3), 1495–1545. https://doi.org/10.1007/s10462-017-9599-6

Hirschberg, J., & Manning, C. D. (2015). Advances in natural language processing. *Science, 349*(6245), 261–266. https://doi.org/10.1126/science.aaa8685

Hussein, D.M.E.-D.M. (2018). A survey on sentiment analysis challenges. *Journal of King Saud University-Engineering Sciences, 30*(4), 330–338. https://doi.org/10.1016/j.jksues.2016.04.002

Jain, A., Kulkarni, G., & Shah, V. (2018). Natural language processing. *International Journal of Computer Sciences and Engineering, 6*(1), 161–167. https://doi.org/10.26438/ijcse/v6i1.161167

Keshavarz, H., & Abadeh, M. S. (2017). ALGA: Adaptive lexicon learning using genetic algorithm for sentiment analysis of microblogs. *Knowledge-Based Systems, 122*, 1–16. https://doi.org/10.1016/j.knosys.2017.01.028

Kwegyiriba, A. (2021). Free senior high school policy: Implications to education access equity in Ghana. *British Journal of Education, 9*(8), 68–81. https://doi.org/10.37745/bje.2013

Lange, S., & Kinyondo, A. (2016). Resource nationalism and local content in Tanzania: Experiences from mining and consequences for the petroleum sector. *The Extractive Industries and Society, 3*(4), 1095–1104. https://doi.org/10.1016/j.exis.2016.09.006

Le Billon, P. (2007). Securing transparency: Armed conflicts and the management of natural resource revenues. *International Journal, 62*(1), 93–107. https://doi.org/10.2307/40204248

Le Billon, P. (2010). Oil and armed conflicts in Africa. *African Geographical Review, 29*(1), 63–90. https://doi.org/10.1080/19376812.2010.9756226

Li, Y., Pan, Q., Yang, T., Wang, S., Tang, J., & Cambria, E. (2017). Learning word representations for sentiment analysis. *Cognitive Computation, 9*(6), 843–851. https://doi.org/10.1007/s12559-017-9492-2

Liu, B. (2012). Sentiment analysis and opinion mining. *Synthesis Lectures on Human Language Technologies, 5*(1), 1–167. https://doi.org/10.2200/S00416ED1V01Y201204HLT016

Liu, B. (2020). *Sentiment analysis: Mining opinions, sentiments, and emotions* (second ed.). Cambridge University Press. https://doi.org/10.1017/9781108639286

Lockwood, M., Davidson, J., Curtis, A., Stratford, E., & Griffith, R. (2010). Governance principles for natural resource management. *Society & Natural Resources,* *23*(10), 986–1001. https://doi.org/10.1080/08941920802178214

Lujala, P. (2017). Transparency and natural resource revenue management: Empowering the public with information? In A. Williams & P. L. Billon (Eds.), *Corruption, natural resources and development* (pp. 58–68). Edward Elgar Publishing. https://doi.org/10.4337/9781785361203.00011

Lujala, P., Brunnschweiler, C., & Edjekumhene, I. (2020). Transparent for whom? Dissemination of information on Ghana's petroleum and mining revenue management. *The Journal of Development Studies, 56*(12), 2135–2153. https://doi.org/10.1080/00220388.2020.1746276

Lujala, P., & Rustad, S. A. (2012). High-value natural resources: a blessing or a curse for peace? In P. Lujala & S. A. Rustad (Eds.), *High-value natural resources and post-conflict peacebuilding* (pp. 19–34). Routledge. https://doi.org/10.4324/9781849775786

Matey, J. (2020). The effect of free senior high school policy on the lives of parents and wards in Ghana. *International Research Journal of Multidisciplinary Scope (IRJMS), 1*, 27–36. https://doi.org/10.47857/irjms.2020.v01si02.038

Ministry of Finance. (2018). *2017 Reconciliation report on the petroleum holding fund submitted to Parliament*. https://www.mofep.gov.gh/index.php/publications/petroleum-reports?page=1

Ministry of Finance. (2019a). *2018 Reconciliation report on the petroleum holding fund submitted to Parliament*. https://www.mofep.gov.gh/index.php/publications/petroleum-reports?page=1

Ministry of Finance. (2019b). *Petroleum reports*. https://www.mofep.gov.gh/index.php/publications/petroleum-reports

Ministry of Finance. (2020). *2019 Reconciliation report on the petroleum holding fund submitted to Parliament*. https://www.mofep.gov.gh/index.php/publications/petroleum-reports?page=1

Ministry of Finance. (2021). *2020 Annual report on the petroleum funds*. https://www.mofep.gov.gh/sites/default/files/reports/petroleum/2020-Annual-Petroleum-Report.pdf

Mohammad, S. M. (2017). Challenges in sentiment analysis. In E. Cambria, D. Das, S. Bandyopadhyay, & A. Feraco (Eds.), *A practical guide to sentiment analysis* (5 ed., pp. 61–83). Springer. https://doi.org/10.1007/978-3-319-55394-8_4

Mohammed, A. K. (2020). Does the policy cycle reflect the policymaking approach in Ghana? *Journal of Public Affairs, 20*(3), e2078. https://doi.org/10.1002/pa.2078

Mohammed, A. K., & Kuyini, A. B. (2021). An evaluation of the free senior high school Policy in Ghana. *Cambridge Journal of Education, 51*(2), 143–172. https://doi.org/10.1080/0305764x.2020.1789066

Muhammad, A., Wiratunga, N., & Lothian, R. (2016). Contextual sentiment analysis for social media genres. *Knowledge-Based Systems, 108*, 92–101. https://doi.org/10.1016/j.knosys.2016.05.032

Musavengane, R., & Siakwah, P. (2020). Challenging formal accountability processes in community natural resource management in Sub-Saharan Africa. *GeoJournal, 85*(6), 1573–1590. https://doi.org/10.1007/s10708-019-10040-2

Must, E. (2018). Structural inequality, natural resources and mobilization in southern Tanzania. *African Affairs, 117*(466), 83–108. https://doi.org/10.1093/afraf/adx048

Nadkarni, P. M., Ohno-Machado, L., & Chapman, W. W. (2011). Natural language processing: An introduction. *Journal of the American Medical Informatics Association, 18*(5), 544–551. https://doi.org/10.1136/amiajnl-2011-000464

Ofori, J. J. Y., & Lujala, P. (2015). Illusionary Transparency? Oil revenues, information disclosure, and transparency. *Society & Natural Resources, 28*(11), 1187–1202. https://doi.org/10.1080/08941920.2015.1024806

Ogbe, M., & Lujala, P. (2021). Spatial crowdsourcing in natural resource revenue management. *Resources Policy, 72*, 102082. https://doi.org/10.1016/j.resourpol.2021.102082

Ogbe, M., Rød, J. K., & Halvorsen, T. (2021). Opinions of Ghanaians on the management of petroleum revenue in Ghana. *African Geographical Review*. https://doi.org/10.1080/19376812.2021.2007410

Orogun, P. S. (2010). Resource control, revenue allocation and petroleum politics in Nigeria: The Niger Delta question. *GeoJournal, 75*(5), 459–507. https://doi.org/10.1007/s10708-009-9320-7

Osei, A. (2013). Party System Institutionalization in Ghana and Senegal. *Journal of Asian and African Studies, 48*(5), 577–593. https://doi.org/10.1177/0021909612465720

Paler, L. (2013). Keeping the public purse: An experiment in windfalls, taxes, and the incentives to restrain government. *American Political Science Review, 107*(4), 706–725. https://doi.org/10.1017/S0003055413000415

Pang, B., & Lee, L. (2008). Opinion mining and sentiment analysis. *Foundations and Trends® in Information Retrieval, 2*(1–2), 5. https://doi.org/10.1561/1500000011

PIAC. (2016). *Public interest and accountability committee report on management of petroleum revenues for year 2015*. PIAC. https://www.piacghana.org/portal/files/downloads/piac_reports/piac_2015_annual_report.pdf

PIAC. (2021). *PIAC 2020 annual report*. PIAC. https://www.piacghana.org/portal/files/downloads/piac_reports/piac_2020_annual_report.pdf

Pozzi, F. A., Fersini, E., Messina, E., & Liu, B. (2017). Challenges of sentiment analysis in social networks: An overview. In F. A. Pozzi, E. Fersini, E. Messina, & B. Liu (Eds.), *Sentiment analysis in social networks* (pp. 1–11). Elsevier. https://doi.org/10.1016/B978-0-12-804412-4.00001-2

Prabowo, R., & Thelwall, M. (2009). Sentiment analysis: A combined approach. *Journal of Informetrics, 3*(2), 143–157. https://doi.org/10.1016/j.joi.2009.01.003

Riaz, S., Fatima, M., Kamran, M., & Nisar, M. W. (2019). Opinion mining on large scale data using sentiment analysis and k-means clustering. *Cluster Computing, 22*(3), 7149–7164. https://doi.org/10.1007/s10586-017-1077-z

Rihoy, E., Chirozva, C., & Anstey, S. (2007). *'People are not happy' – Speaking up for adaptive natural resource governance in Mahenye* (978-1-86808-649-8). (Land reform and agrarian change in southern Africa). http://hdl.handle.net/10566/4436

Romero Valenzuela, J. (2020). Introduction. In *Natural resource governance, grievances and conflict*. Springer VS, Wiesbaden. https://doi.org/10.1007/978-3-658-27236-4_1

Sefa-Nyarko, C. (2016). Civil war in south Sudan: Is it a reflection of historical secessionist and natural resource wars in "Greater Sudan"? *African Security, 9*(3), 188–210. https://doi.org/10.1080/19392206.2016.1208476

Serrano-Guerrero, J., Olivas, J. A., Romero, F. P., & Herrera-Viedma, E. (2015). Sentiment analysis: A review and comparative analysis of web services. *Information Sciences, 311*, 18–38. https://doi.org/10.1016/j.ins.2015.03.040

Shah, R., & Patel, B. (2014). Procedure of opinion mining and sentiment analysis: a study. *International Journal of Current Engineering and Technology, 4*(6), 4086–4090.

Sharma, R., Nigam, S., & Jain, R. (2014). Opinion mining of movie reviews at document level. *International Journal on Information Theory*. https://doi.org/10.5121/IJIT.2014.3302

Shayaa, S., Jaafar, N. I., Bahri, S., Sulaiman, A., Wai, P. S., Chung, Y. W., Piprani, A. Z., & Al-Garadi, M. A. (2018). Sentiment analysis of big data: Methods, applications, and open challenges. *IEEE Access, 6*, 37807–37827. https://doi.org/10.1109/ACCESS.2018.2851311

Singhal, S., Maheshwari, S., & Meena, M. (2018). Survey of challenges in sentiment analysis. In P. K. Sa, S. Bakshi, I. K. Hatzilygeroudis, & M. N. Sahoo (Eds.), *Recent findings in intelligent computing techniques* (709 ed., pp. 229–238). Springer. https://doi.org/10.1007/978-981-10-8633-5_24

Stephens, T. K. (2019). Framework for petroleum revenue management in Ghana: Current problems and challenges. *Journal of Energy & Natural Resources Law, 37*(1), 119–143. https://doi.org/10.1080/02646811.2018.1485269

Subrahmanian, V. S., & Reforgiato, D. (2008). AVA: Adjective-verb-adverb combinations for sentiment analysis. *IEEE Intelligent Systems, 23*(4), 43–50. https://doi.org/10.1109/MIS.2008.57

Takyi, S. A., Azerigyik, R. A., & Amponsah, O. (2019). The effects of multi-track year-round education on the delivery of senior high school education in Ghana. Lessons from global MT-YRE systems. *International Journal of Educational Development, 71*, 102120. https://doi.org/10.1016/j.ijedudev.2019.102120

Tantoh, H. B., Simatele, D. M., Ebhuoma, E., Donkor, K., & McKay, T. J. (2021). Towards a pro-community-based water resource management system in Northwest Cameroon: Practical evidence and lessons of best practices. *GeoJournal, 86*, 943–961. https://doi.org/10.1007/s10708-019-10085-3

Walden-Schreiner, C., Leung, Y. F., & Tateosian, L. (2018). Digital footprints: Incorporating crowdsourced geographic information for protected area management. *Applied Geography, 90*, 44–54. https://doi.org/10.1016/j.apgeog.2017.11.004

Wilson, T., Wiebe, J., & Hoffmann, P. (2005). Recognizing contextual polarity in phrase-level sentiment analysis. In *Proceedings of human language technology conference and conference on empirical methods in natural language processing (HLT/EMNLP)*, Vancouver. https://www.aclweb.org/anthology/H05-1044.pdf

Xia, R., Xu, F., Yu, J., Qi, Y., & Cambria, E. (2016). Polarity shift detection, elimination and ensemble: A three-stage model for document-level sentiment analysis. *Information*

Processing & Management, 52(1), 36–45. https://doi.org/
10.1016/j.ipm.2015.04.003

Yang, B., & Cardie, C. (2014). Context-aware learning for
sentence-level sentiment analysis with posterior regulari-
zation. In *Proceedings of the 52nd annual meeting of the
association for computational linguistics (volume 1: Long
Papers)*, doi:https://doi.org/10.3115/v1/P14-1031