COVID-19 Social Media Information and Misinformation: a Geospatial Analysis of Inter-regional Tweet Disparities in Ghana

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Research

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Abstract

Background

In an era of the global pandemic and social media dominance, trying to control the narrative on COVID-19 has been a challenging task for most governments particularly with news about the disease on various social media platforms. There have even been instances where people have sent false information about the number of confirmed cases, precautionary measures, drugs that boost the immune system which can threaten the lives of some users who are accessing this false information and misconceptions.

Method

This study analyzed spatial differences in Twitter misinformation on COVID-19 across 16 regions of Ghana by scraping 1,167 tweets from Twitter using API access. A total of 514 tweets were analyzed. The data were categorized into three namely; accurate information, misinformation, and other information.

Results

The study results show that 72% of the tweets were accurate, 14% were misinformation and 14% represented other information. Among the regions, Greater Accra had the highest number of accurate information (45 tweets), and the Upper West Region recording the highest number of misinformation (12 tweets).

Conclusion

Spatial monitoring and management of information dissemination are useful for target setting and achievement of direct results in terms of diffusing misinformation and propagating accurate information. We, therefore, recommend official usage of Twitter for COVID-19 information dissemination as this usage will help offset possible misinformation from unformed individuals.

Introduction

The Novel Corona Virus 2019 (COVID-19) was declared a global pandemic by the World Health Organization in March 2020. The rate of spread of the novel coronavirus necessitated the introduction of precautionary measures including a ban on public gatherings, the closure of schools, and religious activities and places, social distancing, frequent hand washing under running water with soap, the use of alcohol-based hand sanitizers and most importantly the need for staying at home, especially when it is not necessary to leave home [1].

Globally, COVID-19 has heightened the use of social media platforms for receiving and sharing information [2], of which Ghana is no exception. News items relating to the pandemic continue to trend on daily basis via various social media platforms including Facebook, Twitter. The low social media monitoring in Ghana has resulted in the creation of an information hub where users of these platforms

access, share, like, and add to the pool of information which is largely untapped and unmonitored. In some instances, false reports have been generated on these social media platforms on COVID-19 in Ghana; including the number of confirmed cases, un-prescribed drugs purported to be the cure for the virus, and politicization of the virus and its management [3]. A situation which was referred to as 'COVID-19 and poverty pornography: the nakedness of the Ghanaian poor' [4].

Ghana is among 40 other African countries that have currently recorded cases of the COVID-19. The country recorded its first case of the novel coronavirus on the 12th of March, 2020 [5]. According to President Akufo-Addo [6], his government had five (5) key objectives to combat the pandemic in Ghana and these were to; 1. Limit and stop the spread of the virus; 2. Contain the spread of the virus; 3. Provide adequate care for the sick; 4. Limit the impact of the virus on social and economic life; 5. Inspire the expansion of the domestic capability and deepen self-reliance. The government of Ghana dedicated an amount of GHS 572 million towards the fight against the COVID-19 pandemic in 2020 [6]. Per the five key objectives of the government of Ghana, this research focused information shared through Twitter towards the achievement of the first two objectives, i.e., to limit the spread of the virus and to also contain the virus, since access to accurate information is seen as a step towards poverty alleviation [7].

Social media has become a part of our worldview [8]. Taking into account the amount of time and frequency of social media use [9], particularly in an era of the global pandemic and movement restriction, it is imperative to consider some pertinent factors such as media monitoring concerning COVID-19 information sharing in Ghana and further geotag comments and feeds which can be detrimental to the fight against COVID-19. This is essential for the development of an appropriate counter-response. In this regard, this study addressed the following questions;

1. How can the origin (geospatial location) of tweets on COVID-19 be obtained?
2. How accurate is the kind of COVID-19 information shared on Twitter social media in Ghana?
3. What are the regional disparities in rates and type of COVID-19 information shared on Twitter?

Social Media and Information Sharing

Globally, the use of electronic media in dispensing information cannot be over-emphasized. Electronic media in recent times has not only helped in globalization but has helped in diverse sectors such as the economy, health, political, social, and environmental discourse [10]. Since the introduction of social media, the world has seen the importance of social networking and content sharing [11]. Social media is rapidly penetrating the modern information society [12]. Social media coupled with web-based applications further enhances user participation, network effects, and contact-sharing [13]. [14] stated that social media has proven to be effective in an organization, particularly in the fields of collective action, and further allows groups and companies to interact with a large number of participants.

Social media despite its incalculable benefits has also posed several challenges. [15] and [16] have outlined challenges posed by social media and paramount among these challenges, according to them, are the strategic surprises which sometimes emerge from a rapid expansion of trends (issues) that are

synchronized and used as a web-based protest. For example, there have been protests on social media mainly by Africans against the proposed initial mass testing of the COVID-19 vaccine in Africa [17].

There are growing trends where sometimes social media is used in inciting the public to verbally assault, threaten, misinform and tarnish the images of groups and individuals [18, 19]. There is, therefore, the need for the introduction of a system that will monitor and check these challenges to curb wrongdoings and to an extent guide the users on these social media platforms, although not for control or censorship. Scholars such as [20, 21, 12], have all argued for some level of media monitoring. Media monitoring can be defined as the *'use of systems and methods to monitor transmissions of media content (such as audio and audiovisual content) to obtain independent and objective data regarding the use of specific media content recordings or works within the transmissions'* [20]. According to Petrovic [20], media monitoring (social) is purposed towards control and responsiveness. This will enhance transparency, privacy, and accountability.

Media monitoring has been successful in obtaining objective data regarding specific media issues on foodborne illness, problematic smartphones among others [22, 23]. However, because the information has an origin which is geographic location, employing Geographic Information Systems (GIS) tools will further equip media monitors not to only extract objective data but further trace the source in order to target damage control plans [24, 25].

GIS has evolved over the years from desktop (standalone) computers to the World Wide Web. GIS functions primarily as a location-based tool for communication and information-sharing [24]. The tool has further enabled websites that offer mapping services such as Google Earth, Bing Maps among others to harness the benefits of the location. GIS (GeoWeb) has become a powerful media that enhances communication among the general public. More importantly, [24] argues that GIS has taken a new role as social media which is seen through two perspectives. First, various users have created their virtual community through online mapping sites which helps them in exchanging information with other users, [26] highlights that about 300,000 people signed on to ARGIS online user community. Secondly, these interactions are not only limited to GIS users [27, 28], for example, participants of Open Street Map in Europe and Canada have been organizing mapping parties over the weekends to map road networks for their neighborhoods. The above roles show a paradigm shift of GIS towards 'social media' via the use of web-based and mobile technologies open to the general public to address everyday problems [24].

Again, social media has incorporated the use of GIS and geospatial technologies in reporting news. Some social media organizations do not only use GIS as a mapping tool but they have incorporated other uses such as georeferencing and interoperability [29] coupled with developing mapping tools for journalism applications. Social media platforms such as Facebook, Twitter, and Instagram are characteristics of web technologies that make use of location [24]. The transformation of social media towards a location-based application has moved social media from cyberspace to real space by adopting geo-location features that allow users to identify the location of other users at a particular time. A classic example is Facebook's location feature adopted in August 2010.

Undoubtedly, social media platforms have become the go-to sites for daily information [30] yet, the content that is generated from these websites remains largely untapped. In an era of a global pandemic, trying to control the narrative on COVID-19 has been a challenging task for most governments particularly with news about the disease on various social media platforms [31, 32]. There have been instances where people have sent false information about several confirmed cases, precautionary measures, drugs that boost the immune system [32]. This misinformation can threaten the lives of some users, especially when they apply a particular social media prescription that is contrary to the truth.

The study aims to employ GIS techniques to monitor social media posts (geolocation) about COVID-19 to help address issues of misconception and misinformation to help end this pandemic.

Methods

Study Area

Ghana, the study area is located in West Africa sub-region, along the coast of the Gulf of Guinea. In terms of latitude and longitude, Ghana lies between 4°45'N and 11°N, as well as 1°15'E and 3°15'W respectively. Ghana has a total land area of 238,535 km² (92,099 sq. mi). It shares borders with Burkina Faso to the North, the Gulf of Guinea to the South, Togo to the East, and the Ivory Coast to the West. Currently, Ghana has 16 administrative regions which have been sub-divided into 275 districts.

In terms of population, Ghana is estimated to have about 30 million people and has maintained an average annual growth rate which is above the world average since 1970. Currently, Ghana's high growth rate is 2.1% pa and it is likely to continue for quite some time because about two-thirds of the population is under age 30. Ghana had a population of about 30,083,000 as of June 2019 out of which 29% are under age 15 while 57.8% are persons between age 15 and 65 [33].

Ghana's education system has been grouped into three main parts: Basic Education, secondary cycle education, and tertiary education. The "Basic Education" lasts for 11 years (ages 4–15). It is divided into Kindergarten (2 years), Primary School (6 years), and Junior High (3 years). Junior High School (JHS) ends with the Basic Education Certificate Examination (BECE). School enrollment, primary (% net) in Ghana was reported at 84.48 % in 2018, according to the World Bank [34]. In general, Ghana has a very high adult literacy rate, estimated to be around 79% in 2018 [35].

Ghana has one of the highest rates of mobile phone usage penetration in West Africa. It was estimated that by the end of 2019, mobile phone adoption stood at 55% [36]. Ghana is said to have approximately 30 million people in 2019, of which over 11 million are considered regular internet users. Over 5.6 million out of the 11 million internet users are active on social media [37]. Facebook has an active user of 43% out of the total social media active users, 29% are active Twitter users, Pinterest has 13% active users, 10% use Instagram and lastly, 5% actively using YouTube. In the year 2019, Ghana placed 9th on the

global ranking of active social media users. Figure 1 is the map of Ghana showing the 16 administrative regions and their capitals.

Methodology

This research extracted geotagged tweets from Twitter, one of the major social media platforms used in Ghana. Twitter was used because the platform utilizes location capabilities, it makes available an API for its data scraping, and also because a lot of conversations happen on Twitter, therefore, making it the right place to mine social media posts with their location.

Data required and source

Two types of data; spatial data, including Ghana and regions boundaries, and COVID-19 tweets locations sent by Twitter users. The Ghana regional boundary was obtained from the Remote Sensing and GIS Applications Laboratory of the University of Ghana website (www.rsgislab.ug.edu.gh). The main data used for this research was tweets that were sent about COVID-19 from April to July 2020. The specific COVID-19 tweets are the geolocation data and types of COVID-19 tweets from Twitter. The tweets extracted were from users who have enabled tweet geotagging in their profile settings. The shapefile of the study area was also required in performing the analysis.

The geotagged tweets were sourced from Twitter (www.twitter.com) using their API and further processed into geolocation data for analysis.

Software and their usage

Three main applications software were used in this study, namely; ArcGIS Suite, Visual Studio Code, and Microsoft Excel.

Visual Studio Code is a code editor refined and optimized for building and debugging modern web and cloud applications. In this study, it was used to run the python scripts to scrape data from Twitter.

Microsoft Excel was used to create grids of text, numbers, and formulas for specific calculations. It was also used in reading and cleaning the data scraped from Twitter in CSV file format. It was used to create and generate graphs for the analysis.

Lastly the ArcGIS suite (ArcGIS Pro and online); ArcGIS Pro, is an application under the Esri Geospatial Cloud. This software is arguably ahead of everything else on the market in terms of data visualization, advanced analysis, and authoritative data maintenance in both 2D and 3D. This software was used to plot the scraped geotagged tweets for geospatial analysis.

ArcGIS Online on the other hand is an online platform where individuals and organizations manage all their geographic content in a secure, cloud-based environment. It was used to create web maps and web apps from the geotagged data scraped from Twitter. The scraped data was published online to the ArcGIS server where it was used to create a web map as well as create a web app

Data scraping from Twitter

The first step in scraping data from Twitter was acquiring a developer account from a pre-existing Twitter account. Next, we created an application from the developer account to acquire an API key for configuration. Tweepy is a python library that has a prebuilt function for accessing the Twitter API. This library was installed using Windows command-line interpreter (i.e. Command Prompt; CMD).

A script in python was written to create authentication for accessing Twitter as a valid user. API object was used to request the data through the Twitter developer application created. A file created in CSV file format will act as a database where the data was written to. Headings such as username, timestamp, tweet, longitude, latitude, and hashtags were created in the CSV file created.

Finally, a grid was created on the Ghana boundary, from which the data was scrapped. A grid of 4 rows and 3 columns making 12 grids was created using the Mean Centre tool in ArcGIS Pro. After the grids were created, the Central Feature tool in ArcGIS Pro was run to identify the most centrally located feature from the grid created. The grid was clipped to the Ghana region's boundary using the Clip tool. The longitude and latitude of the central points created with an 80km buffer were used in the script to scrape the data from Twitter.

Data cleaning and categorization

The data that was scraped from Twitter were written into the CSV file format and was later opened in Microsoft Excel for further processing. This was where the data was cleaned and duplicates tweets were removed for further analysis to be done. The cleaned data were categorized into accurate information, misinformation, and others. Accurate information per the study was defined as information that talked about safety precautions, spreading of calm, creation of awareness, curbing the spread of the virus as well as supporting the fight against coronavirus as defined by the World Health Organization (WHO). Misinformation was a category of tweets that contained information on the spread of fear, stigma, and unapproved methods of treating COVID-19 as well as aiding in the spread of the virus. The category classified as Other were tweets that contained the keyword or hashtag relating to the coronavirus such as #covid19, COVID-19, or coronavirus but the tweet content has no relation to neither stopping the spread of the virus nor spreading misinformation on the virus.

The data categorization was done primarily using the WHO website supported by three different fact-checking procedures; (1) by using websites such as www.factcheck.org, www.hoax-slayer.com, and www.snopes.com to vary certain tweets on the behavior of the virus. (2) by using certain keywords to group the tweets into accurate, misinformation, and others. Keywords and phrases that were used for accurate information gathering included; fight against, join, together, stay home, and stop the spread. Also, keywords and phrases for categorizing misinformation were, COVID-19 is a hoax, non-existent, by July, and fake results. (3) Finally, manual categorization of the data tweet by tweet. It is, however, important to state that the classification tweets and final validation of accuracy were based on WHO publications on COVID-19.

Density analysis was performed to determine which areas within the study area rely on social media the most for information sharing and connecting with friends and family during the peak of the pandemic in Ghana i.e., April- July 2020.

Data analysis

The period of the geotagged tweets that were scraped, and analyzed between April 1, 2020, and July 31, 2020. This time frame was chosen because it was the peak of COVID-19 and part of the time when the country was locked down and people needed information about self-protection and also about the state of affairs within the country as a whole. A 3x4 grid which gave a total of 12 grids were created to cover Ghana. Essentially the grid was meant to help create a grid center as a point that will be used in creating a buffer.

The total number of geotagged tweets from the period (April to July 2020) was spatially joined to the Ghana region shapefile. Density analysis was performed on the regional new dataset and the result was grouped into intervals and color-coded to symbolize the values they represent. Microsoft Excel was used to generate graphs and charts to add more meaning and readability to the data.

Results

The results of the analysis are presented in two parts; the first part shows the results of the various methods used in data acquisition. The second part also focuses on the results of the regional differences in information and misinformation of COVID-19 in Ghana. Figure 2 shows the grid and their central point used.

The python-based data scraping script requires a buffer to scrape that geotagged data. The grid provided 12 points across Ghana and optimization techniques helped in the creation of an 80km buffer around each point and that provided the output from the data scraping. The python script was able to scrape the needed data as intended. The results were written in Comma Separated (CSV) format. In total, 1,167 tweets were scraped from Twitter using the python script through the Twitter API. Below is a sample of the scraped data.

The data scraped was cleaned to make it easy for readability and also suitable for analysis. There were 653 duplicate tweets and this was because the 80km buffer employed caused some of the buffer zones to overlap. All the overlapping data were removed for the data to fit within their designated grid. From the initial 1,167 tweets, the 653 tweets were removed, leaving 514 clean tweets, from which the various analyses were performed.

The clean tweets were categorized into Accurate Information, Misinformation, and other information after the validation process was completed. From the 514 total tweets, 368 tweets, representing about 71.5% were accurate information, 71 tweets, representing 14% were misinformation and lastly, 75 tweets, representing about 14.5% were categorized as other information (Table 1).

Table 1
Data categorization types

Info Type	Count of Info Type
Accurate Information	368
Misinformation	71
Other Information	75
Total	514

In Table 2, we present samples of tweets that we classified as accurate information, misinformation, and other information.

Table 2
Samples of information, misinformation, and others

Tweet categorized as Accurate Information	Tweet categorized as Misinformation	Tweet categorized as Other Information
<p><i>#"FACT: COVID-19 is NOT airborne.</i></p> <p><i>The coronavirus is mainly transmitted through droplets generated when an infected person coughs, sneezes, or speaks.</i></p> <p><i>To protect yourself.</i></p> <p><i>keep 1m distance from others</i></p> <p><i>disinfect surfaces frequently</i></p> <p><i>wash/rub your hands</i></p> <p><i>avoid touching your face"#</i></p> <p><i>~ @AbdulRasheedAw</i></p>	<p><i>"Akua Donkor - "COVID-19 is a hoax and non-existent. They don't want us to speak that's why they've ordered us to wear masks so they can win the elections" ~ @OseiAkoto_Kanu</i></p>	<p><i>Oh! No, I pity Secondary School Students; they will write an Essay on this COVID-19 when school resumes? ~ @iam_clinton</i></p>

The accuracy or otherwise of tweets were classified after validation from factcheck.org and snopes.com to confirm their authenticity.

The 514 geotagged tweets were plotted to show their spatial distribution across Ghana. Figure 4 represents the exact location where the tweets were sent from and in the various regions of Ghana.

Generally, tweets came from all regions of Ghana. Table 3 represents the regional breakdown of tweets by total and percentages within the study period.

Table 3
Regional breakdown of the information

Region	Tweet Count	% Misinformation	% Accurate Information	% Other Information	Total
Ahafo	8	25	63	13	100
Ashanti	46	22	65	13	100
Bono	27	15	74	11	100
Bono East	24	8	75	17	100
Central	15	7	93	0	100
Eastern	35	6	80	14	100
Greater Accra	59	8	80	12	100
North East	20	20	60	20	100
Northern	49	12	76	12	100
Oti	15	27	73	0	100
Savannah	51	14	65	22	100
Upper East	27	11	74	15	100
Upper West	54	22	48	30	100
Volta	29	14	83	3	100
Western	39	8	85	8	100
Western North	16	13	63	25	100

Table 3, shows a regional count of tweets as well as the percentage tweets categorization as accurate information, misinformation, and other information. Greater Accra region recorded the highest number of tweets with a count of 59 while Ahafo came last with a total of 8 tweets.

The breakdown of tweets per region has been represented graphically in Fig. 5.

Analysis of misinformation tweets as a percentage of total tweets shows that 27% of tweets from the Oti region are misinformation, one (1) out of every four (4) tweets from the Ahafo region were

misinformation. Ashanti and the Upper West regions have 22% of their tweets being misinformation. Eastern and Central regions have the lowest level of misinformation, with 6% and 7% respectively.

Central region and Oti region recorded zero (0) other information, whilst Volta region recorded one (1) other information. Upper West recorded the highest other information with 16 tweets followed by the Savanna region with 11 tweets.

Regional tweets were grouped as high ($40 \leq$ tweets), medium (20–39), and low (1–19). High-tweet regions include Greater Accra, Upper West, Savanna, Northern, and Ashanti, medium-tweet regions are Western, Eastern, Volta, Bono, Upper East, Bono East, and North-East regions while the low tweet regions include Western North, Central, Oti, and Ahafo regions.

Table 4
Range of tweets per region for the density analysis

Class	Range of Tweets per region	
High	$40 \leq$	Greater Accra, Upper West, Savanna, Northern, and Ashanti
Average	20–39	<i>Wester, Eastern, Volta, Bono, Upper East, Bono East, and North-East</i>
Low	1–19	<i>Western North, Central, Oti, and Ahafo</i>

The reddish color in the map shows regions with the highest number of geotagged tweets that were scraped from Twitter. The yellow-orange color shows regions with the average number of tweets. Lastly, the light pink color shows the regions with the least number of tweets.

Discussion

Thousands of posts are shared on social media every minute. These numerous posts contain information about every aspect of life. Information sharing on social media on COVID-19 is no different. Analysis of the kind of information shared about the novel coronavirus through social media, as part of the efforts to combat COVID-19 misinformation motivated this study. The study was embarked on to find out whether the information being shared is accurate or misinformation and to understand spatial differences. A large amount of geotagged data was expected to be scraped from Twitter and to be analyzed. Unfortunately, not every Twitter user adds their location to their post when they tweet. In all, 1,167 data were scraped and after cleaning the data more than half of the data was deleted leaving 514 tweets, less than 50% as valid for analysis. The results of this study support the claim by some scholars that indeed such geotagged tweets can be used to develop real-time maps. This is because the Twitter API can scrape tweets as soon as they are tweeted once they are location-enabled. Non-GIS users also get the opportunity to participate in GIS activities through geotagged tweets [24]. A typical scenario is the scraping of geotagged tweets for GIS analysis. Thus, Twitter users who per their location sharing add

geolocation information to their tweets. Studies have shown that geotagged tweets analyzed over time can be used to develop real-time maps which will further enhance communication and campaigns [31, 38] and may be a useful tool for education on COVID-19 and other diseases. The challenge of misinforming the people about COVID-19 is that it rather increases infections through unsafe practices, lack of adherence to best practices, stigmas, and observation of protocol. Understanding the type and accuracy of COVID-19 information helps the management team to develop and implement early detection and damage control for addressing the negative impacts of misinformation. In Fig. 7 we conceptualize information and misinformation pathways; that is social media information flow and its impacts without intervention and with intervention.

Early detection of misinformation reduces the cost and time of damage control, government and individual efforts, and control of the spread of the virus.

From Table 3, the Greater Accra region had the highest number of geotagged tweets. This can be linked to the fact that Greater Accra is the region with the highest number of literate and high-income populations in Ghana and are more likely to be Information Technology inclined than regions such as Ashanti, and Northern.

The plotted map of the geotagged tweets in Fig. 4 indicates where all the tweets were coming from. Government agencies and other humanitarian agencies that are keen on helping in the fight against the virus can identify areas within the country that have less knowledge about the virus and hence run campaigns and interventions to publicly educate people in such areas.

Furthermore, from Fig. 5, based on all the geotagged tweets it can be seen that per the breakdown of the three information types, accurate information recorded the highest values across each of the 16 regions. This high amount of accurate information sharing on COVID-19 may be attributed to the reason why Ghana's coronavirus case count is still on the low compared to other countries in Africa and the world at large. This social media information sharing has given Ghanaians access to the right information about the pandemic; awareness creation, the mode of transmission, the effects, and the measures to minimize the spread of the virus.

Lastly, with the type of information extracted from the data it can be seen that social media indeed plays a major role in information dissemination about health (such as the coronavirus pandemic), education, the public outcry among others. Twitter, therefore, provides a very high coverage but low-cost education and information platform for the official dissemination of information to many Ghanaians; given that mobile phone, penetration is close to 90% of Ghana. We, therefore, recommend official usage of Twitter for COVID-19 information dissemination as this usage will help offset possible misinformation from unformed individuals.

Declarations

Ethics approval and consent to participate

Not required.

Consent for publication

No require

Availability of data and materials

All data used is presented in the work.

Competing interests

We declare no competing interests.

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Authors' contributions

Both Author, Alex Barimah Owusu (ABO) and Richmond Takyi Hinneh (RTH) discussed and started this work. RTH downloaded the data on tweets, participated in writing and editing. ABO also perfumed analysis, contributed in writing, editing and submission.

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Figures

Figure 1

Map of the study area (Ghana) (Source: Author 2021)

Figure 2

(a) Grids created in Ghana. (b) Mean Centre points and clipped grids. (Source: Author 2021)

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Page Layout

Formulas

Data

Review

View

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12

</

Figure 3

Snapshot of raw scraped data (Source: Author 2021)

Figure 4

Plotted geotagged tweets from Twitter (Source: Author 2021)

Figure 5

Breakdown of tweets per region (Source: Author 2021)

Figure 6

Density analysis results of tweets per region. (Source: Author 2021)

Figure 7

conceptualizes information and misinformation pathways (Source: Author 2021)