Volume 18 Issue 8
Originally issued as F1

Global Journal of human-social science: F
Political Science
Volume 18 Issue 1 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

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Abstract- An election is one of the most important human institutions as its outcomes may have diverse effects on the people and the nation as a whole. Election offers people the opportunity to select a leader or set of leaders who would oversee the affairs of the people, their communities and the nation at large for a period. Peaceful elections have contributed to the democratic and stable atmospheres in most countries. Election involves a lot of processes such the casting of votes, counting of the vote cast, displaying of results in figures and numbers and declaring of the winner for the poll. Each of these processes is crucial to the creditability and transparency of the election, but displaying, and the representation of election result are more crucial since figures and numbers can be manipulated easily by the electoral commission. One may argue that this problem of electoral data representation can be solved statistically by using graphs and bar chart or pie chart, but the locations of the electoral colleges would be statistically very hard to fix. An alternative approach to electoral data representation is through the use of Geographic Information Systems (GIS). Geographic Information Systems can display election results visually and represent the locations where these election results were being obtained.

GJHSS-F Classification: *FOR Code: 360199*

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The Contributions of Geographic Information Systems (GIS) to the Creditability and Transparency of the 2016 General Elections in Ghana

Clement Kwang [α], Ishmael Adjei [σ] & Edward Matthew Osei Jnr [ρ]

Abstract- An election is one of the most important human institutions as its outcomes may have diverse effects on the people and the nation as a whole. Election offers people the opportunity to select a leader or set of leaders who would oversee the affairs of the people, their communities and the nation at large for a period. Peaceful elections have contributed to the democratic and stable atmospheres in most countries. Election involves a lot of processes such the casting of votes, counting of the vote cast, displaying of results in figures and numbers and declaring of the winner for the poll. Each of these processes is crucial to the creditability and transparency of the election, but displaying, and the representation of election result are more crucial since figures and numbers can be manipulated easily by the electoral commission. One may argue that this problem of electoral data representation can be solved statistically by using graphs and bar chart or pie chart, but the locations of the electoral colleges would be statistically very hard to fix. An alternative approach to electoral data representation is through the use of Geographic Information Systems (GIS). Geographic Information Systems can display election results visually and represent the locations where these election results were being obtained.The 2016 Ghana general election became one of the most successful polls conducted in Ghana because of the roles that Geographic Information Systems played in displaying, delivering and analyzing of the election results. All political parties involved were satisfied with the outcome of election results, and it was the first time, no post-election complains and conflicts occurred.

I. Introduction

An election is one of the most important human institutions as its outcomes may have diverse effects on the people and the nation as a whole. Election offers people the opportunity to select a leader or set of leaders who would oversee the affairs of the people, their communities and the nation at large for a period. Peaceful elections have contributed to the democratic and stable atmospheres in most countries. For instance, countries like Mozambique (1994), Sierra Leone (2002), Liberia (2005) and the Democratic Republic of Congo (DRC) (2006) ended the era of civil wars through the election (Maendeleo Policy Forum Report, 2016).

On the other hand, elections have been used as a means for autocratic regimes, violence and all forms of manipulation in some African and Asian countries. Elections in Côte d'Ivoire in 2010, Kenya in 2007, and 2017, Zimbabwe in 2008, Guinea Bissau and Mali in 2012 ended in political instability and loss of property and lives (Maendeleo Policy Forum Report, 2016).

The basic purpose of elections isfor people to express their choice on particular leadership style but in most cases, this tends to be a different thing as most elections are being characterized by violence, fear, and uncertainty of the stability of the nation even before and after the election. For a fair, free and transparent election, a lot of measures should be taken before, during and after the election. Electoral management should be a continual process and must not be only during a particular election period.

Maendeleo Policy Forum Report, (2016) states that the reluctance or unwillingness of political parties or participating candidates to accept the outcome of election results in good faith is one of the challenges facing most elections. The participating candidates in most cases feared the results of the election may be manipulated thereby denying the reflections of the people's decision in the election.

Geographic Information Systems, particularly Web GIS, can offer the solutions to electoral mistrust regarding the outcome of the results. Geographic Information Systems serves as a platform for data manipulation, spatial analysis, and visualization of relationships, patterns, and trends of spatial data. Location data is vital to the operations of electoral commission ("Elections and Redistricting, nd") as these locations data are in the form of polling stations, constituencies, and electoral colleges. The results from the polling stations and electoral constituencies can then be mapped in real times as maps and graphs for easy and visual analysis of election results' patterns and trends. The visualization, the analytic and the mapping

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capabilities of Geographic Information System could play a role in the acceptance of the outcome of the election by all the participating parties.

Despite the contributions of Geographic Information Systems to the traceability and transparency of election results, much has not been documented in the literature for easy reference and publicity. Most developed countries like USA and United Kingdom have been using the application of Geographic Information Systems during elections, but for the undeveloped countries, the case is different. This paper intends to illustrate the contributions of applying Geographic Information Systemsin the 2016 Ghana general elections.

a) The History of Ghana's Electionsin the Fourth Republic (1992-2016)

Governance in Ghana's first to third republics was been characterized by the alternation of both democratically elected governments and military rulers. The end to the different means by which ruling governments get power occurred in 1992. In April 1992 a referendum was conducted through the leadership of the then military government, the Provisional National Defence Council (PNDC) to approve a constitution which will guide all electoral conducts in Ghana. This referendum was as a result of the PNDC government's agreement with the opposition parties at the time to return Ghana to multiparty and constitutional governance (Frempong, 2015).

Ghana's return to constitutional rulings in the fourth republic aimed at allowing the citizens to choose the leaders they like and also to be able to comment on ruling governments activities. As Frempong (2008) indicates, ''elections are a major institutional pillar of liberal democracy. They provide the platform for exercising the core rights associated with democracy – freedom of speech, association, choice, and movement''. Ghana's fourth republic which has been an election based on choosing governments and other leaders started in 1992. The first Presidential and Parliamentary elections in this republic were conducted in November and December 1992 respectively after a referendum in April 1992 for the country to embark on multiparty constitutional rulings. However the 1992 presidential election was been disputed by the opposition parties, and as a result, they boycotted the parliamentary election which was held in December that same year. Although the presidential election was successful, the opposition parties argued that the incumbent government rigged the election. The opposition party at the time wrote a book entitled, "The Stolen Verdict" to highlight the cases of election malpractices and demanded explanations from the electoral commission (Frempong, 2015). Despite the alleged electoral malpractices and disagreement by the opposition parties the then incumbent government led by Jerry John Rawlings was sworn in on 7th January 1993 as the first president of the Fourth Republic.

After the first election in the fourth republic, Ghana has successfully conducted six successive presidential and parliamentary elections. They are 1996, 2000, 2004, 2008, 2012 and 2016 elections. Three of these elections are characterized by incumbent governments been re-elected (1996, 2004 and 2012), and the other three (2000, 2008 &2016) have been an alternation of powers from the incumbent party to the main opposition party. The 2000 and 2008 alternation of powers happened after run-offs (Frempong, 2015). The 2012 presidential election is being considered as a historical election in Ghana's fourth republic by the people of Ghana because it was the first time an opposition party failed to concede a defeat. The electoral commission declared the incumbent party National Democratic Congress (NDC) led by John Dramani Mahama as the winner but the NPP led by Nana Akufo-Addo refused to concede defeat but rather petition the Supreme Court in line with the Article 64 of the 1992 constitution. This Article allows a citizen of Ghana to challenge the validity of presidential election within twenty-one days after the declaration of results. Nana Akufo-Addo, his running mate Mahamudu Bawumia and their chairman at the time Jake O. Lampty filed a petition with John DramaniMahama and the Electoral Commission. The court sat on this petition for eight months, but at the end, the Court upheld John DramaniMahama's victory. (Frempong, 2015).

One important thing to note about Ghana's election in the fourth republic is that elections are being contested by several parties, but only two parties have been winning the presidential seat and majority of the parliamentary seats. It is either the NDC retaining power or the NPP winning and vice-versa. The other parties just join to add up to the numbers or to demonstrate the beauty of Ghana's democracy. Also, there is always uncertainty about which of the two main parties win a particular election before a final result comes out.

II. Materials and Methods

Creating maps and geo database for election results is one of the simplest tasks of Geographic Information Systems. The materials required for this task are the election results (tabular data) and geographic data (electoral constituency or college map and the regional or state map).The election results were first compiled in Microsoft Excel spreadsheet with the name of the electoral colleges or constituencies and common ID number that would be used as a link between the tabular data and geographic data for the election results to be mapped. This common ID number must be added to the attribute table of the geographic data since without that it would be difficult to link the tabular data. A field was also created in the tabular data for the margin

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difference of one of the candidates of the election. The margin difference was obtained by subtracting the selected candidate's vote from the other candidate's vote for each of the constituencies. Negative values indicate lost and positive figures show constituencies where the candidate won the poll.

The tabular data and geographic data were imported into GIS environment such as QGIS or Arc GIS for the creating of the electoral maps, but after the importation, the immediate task is the linking of the tabular data (election results) and geographic data (electoral constituency map) by using the Join option. The tabular data was joined or linked to the attribute data of the geographic data and not vice visa because of the location information (coordinates) of the geographic data. During the Join, the common ID number was selected from both the tabular and geographic data, and after completing the join process, all the attribute fields of the tabular data must appear within the attribute data of the geographic data.

The use of map symbology is a communication tool in Geographic Information Systems for the interpretation and understanding of information because of its ability to reveal patterns in the analyzed information or data. There are three types of symbolizing data in Geographic Information System, and the choice of the method depends on the data type. The election results were symbolized by right-clicking on the linked geographic tabular data and selecting the quantities option of symbology. The quantities option was chosen to map the election results because the quantities permit data to be represented based on the numeric attributes of data and election result is about comparing the number of votes of candidates.

The margin difference field would be selected as an input variable to symbolize the election results. The values of the margin difference were classified into three classes; the first class contains the negative value from the margin different values, the seconded would be zero value, and the third class would be the positive value. The range of negative values to zero means lost to the selected candidate, and a win to other candidate, and therefore his party's color would be assigned. On the other hand, a value ranging from zero to positive mean win for the selected candidate, and his party's color was assigned. After the selection of party colors, the whole map was change to the colors of the parties. The electoral maps produced and used by the media houses during the 2016 Ghana general elections were created by using this method.

III. Results and Discussions

Election involves a lot of processes such asthe casting of votes, counting of the vote cast, displaying of results as figures and numbers and declaring of the winner for the poll. Each of these processes is crucial to the credibility and transparency of the election. Displaying election results as figures and numbers can often be manipulated and are most at times difficult to visually conceptualize their meanings. One may argue that this problem of electoral data representation can be solved statistically by using graphs and bar chart or pie chart, but the locations of the electoral colleges would be statistically very hard to fix.

An alternative approach to electoral data representation is through the use of Geographic Information Systems (GIS).Geographic Information Systems can display election results visually and represent the locations where these election results were obtained from. Electoral maps offer an immediate and concise understanding of election results rather than the usage of numbers or charts in displaying the election results. The electoral maps permit visual exploration of the election results and help in showing the spatial correlation between results for better interpretation and analysis. Electoral maps play a vital role in evaluating and accessing the spatial voting patterns in any election.

Ghana is one of the countries where the democratic form of governance is being practiced since the adoption of the 1992 Ghana constitution. Democratic governance is mainly about converting citizens' choices into policy action through decision-making processes and through elections citizens can exercise their preferences and hold government accountable. Elections have a role in the sustainability of democratic governance and it is in line with this, that Ghana keeps improving its elections through the use of modern technologies such as the Geographic Information systems (GIS), Remote Sensing and Global Position Systems (GPS).

The 2016 Ghana's general election made use of the application of Geographic Information Systems in displaying the election results on the administrative map of Ghana. Some electoral maps were prepared and used by media houses in Ghana to depict the trends of the 2016 Ghana general elections for easy analysis and discussion by program panels as shown in figure 1, 2, and 3. These electoral maps gave viewers a better understanding of the landscape of the 2016 elections. Some of the maps prepared and used by some media houses are being discussed in detail regarding their contributions to the success of the 2016 Ghana general elections.

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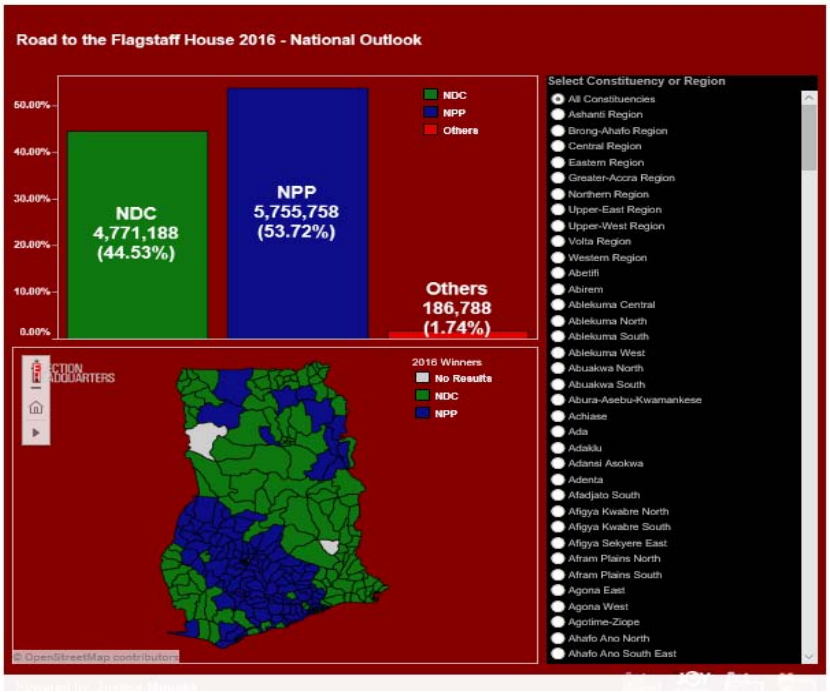
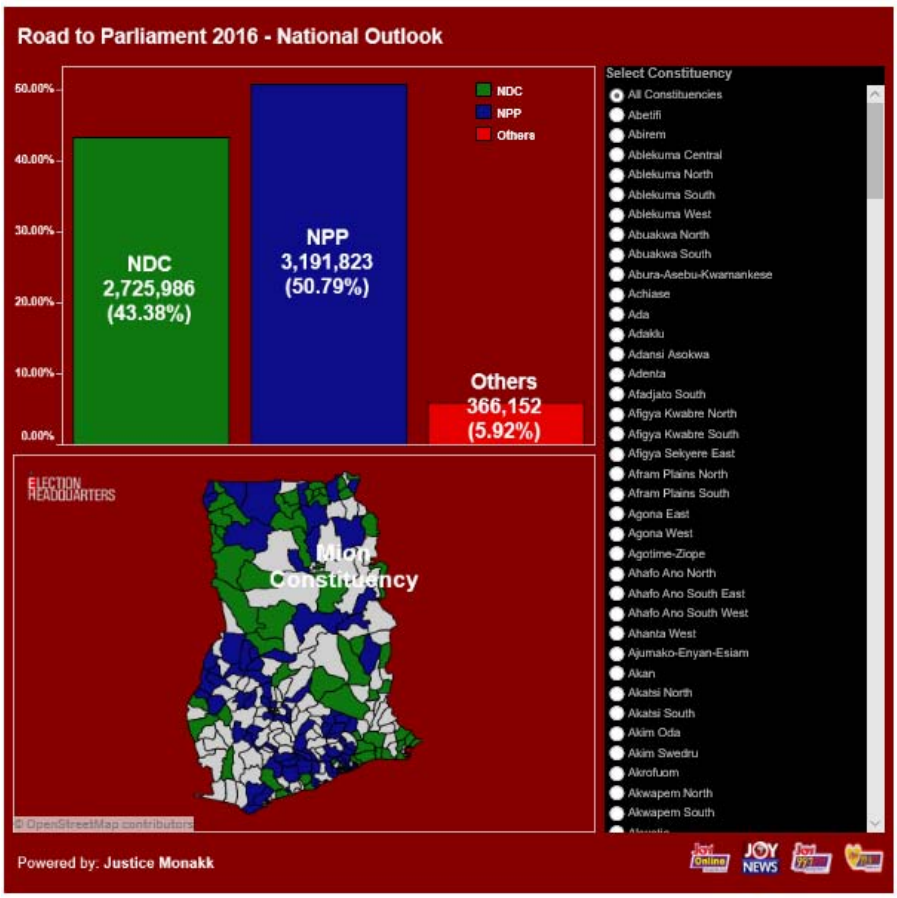


Source: http://www.myjoyonline.com/ghana-news/2016results.php

Figure 1: The presidential electoral map of Ghana 2016 general election.



Source: http://www.myjoyonline.com/ghana-news/2016results.php

Figure 2: The parliamentary electoral map of Ghana 2016 general election

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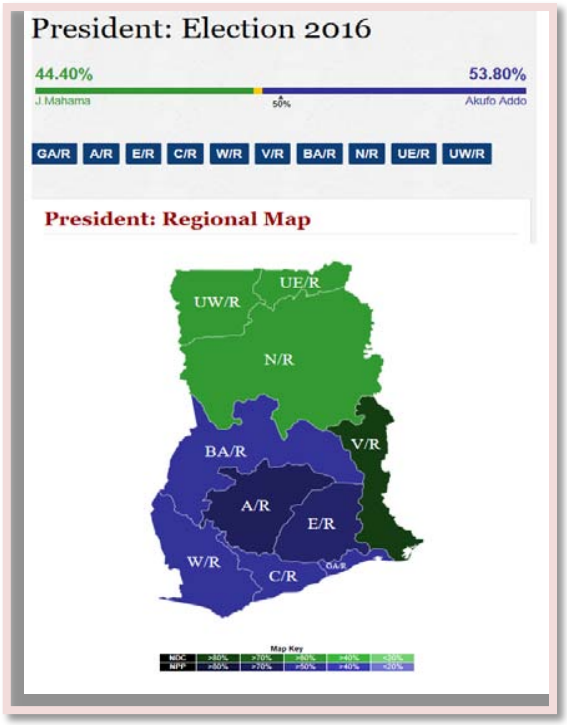
Figure 1 and figure 2 show the presidential and parliamentary electoral map of the 2016 Ghana general election results respectively. These electoral maps were taken from My joy online website. During the 2016 Ghana general election, these maps were broadcasted live on Adom TV, Joy news and Adom online to show the patterns and trends of the election result. This electoral map was made up of the 275 electoral constituencies of Ghana, and as the constituencies' results are released, the map was being colored according to the winner of the poll. The names of all constituencies were shown on the map, and with a click of the button, the election result and winner of the selected constituencies would be displayed by the user. Other spatial analysis such as the constituency with highest votes, selecting and displaying of constituencies won by a particular candidate, constituencies with unavailable election results can be easily performed by the user. Television viewers had the opportunity of viewing the trends and patterns of the 2016 general election at the comfort of their homes, offices, and shops. This, therefore, enhanced the transparency and the credibility of the 2016 election. Even before the declaration of the winner of the presidential election by the electoral commissioner, people of Ghana and world were already aware of the outcome of the election results,and there was no way the results could have been manipulated by the electoral commissioner.



Source: http://ghanaelections.peacefmonline.com/pages/2016/president/

Figure 3. The presidential electoral map of Ghana 2016 general election

Figure 3 displayed the result of the presidential of the 2016 Ghana election and it was obtained from Peacefm website. This map and other electoral maps were also broadcasted live on Utv during the 2016 Ghana general election. This map displays the colors of the two main political parties in Ghana because the other political parties won none of the regions in Ghana during the 2016 general election. The blue colored were areas where NPP won, and the green colored were wins for the NDC. The intensity of the colorindicates the magnitude of the votes obtained by the winning party. The dark blue colored were the stronghold regions of NPP whiles the darkgreen colored was the stronghold region of NDC. From the map, NPP won all the regions of southern Ghana whiles NDC won the northern part of Ghana.

These maps gave full meaning to the 2016 Ghana general election results with a just glance of an eye. The good part is that any person without Geographic Information Systems background could read and understands the meaning of the election results once they were displayed on the maps by the GIS expert.

IV. Conclusion

The roles that Geographic Information Systems plays on the credibility and transparency of election are numerous; it presents election results in a more meaningful form that are easy to deduce and analysis and this in a way would help reduce doubt and confusions in people's mind even before the official declaration is done by the electoral commissioner. The electoral maps can serve as reference materials to analyze and study the electoral spatial landscape of previous elections to project an outcome of future elections. The query capabilities of Geographic Information Systems offer users the opportunity to do a more detailed examination of the election results constituency by constituency or region by region in a rapid manner. The electoral maps for the 2016 Ghana general are available online through the Web GIS and can be accessed by anybody in any part of the globe.

The 2016 Ghana general election became one of the most successful polls conducted in Ghana because of the roles that Geographic Information Systems played in displaying, delivering and analyzing of the election results. All political parties involved were satisfied with the outcome of election results, and it was the first time, no post-election complains and conflicts occurred.

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Early View

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