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Harnessing Big DataAnalytics for Sustainable and Renewable Energy Development in West Africa: A Critique of Some Big Data Projects

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Abstract
Hydropower is the safest and cheapest renewable sources of electrical energy. However the effect of climate change on rivers and lakes which are major sources of hydropower energy has been discussed in several literatures. Much attention is being given to climate data analytic in the developed world but there is paucity of data sets on climate change in Ghana and most other countries in West Africa. This work takes a critique view of how big data analytics tools are being deployed in some climate change projects across the world. Concerted collaborative actions is therefore needed towards sourcing data sets on climate change and developing analytic tools to harness the power of big data for sustainable and renewable energy development in West Africa.

Keywords
big data–Hydropower–sustainability–Renewable

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Contents

1. Introduction

Electrical energy is an important infrastructure to a nation's socio-economic development(Mehta & Mehta, 2005;Flavin & Aeck 2005;Stiftung, K. A. 2012; Lorde, Waithes & Francis, 2010) and cannot be over emphasized given the central role it plays in driving all the major forces of a nation's economic factors such as manufacturing, telecommunications, health etc.(Amponsah Owusu 2010; Oyedepo, 2012; Ganda & Ngwakwe, 2014).

Hydropower energy provides one of the huge sources of energy, contributing about 16% of world power supply and 86% source of renewable energy (Kumar, A., T. Schei, A. Ahenkorah, R. et. al. 2011).This is due to the sustainability and renewable nature of water which is found in abundance and inexhaustible. It is estimated that water makes up about 71% of the earth (Matt William, 2014; The USGS Water Science School, 2015). The other reason lies in its capability to improve energy efficiency as a clean, safe and cheap source of electrical energy. It is friendlier because it emit none by-product unlike thermal energy generation. Hydropower harnesses the energy of water moving from higher to lower elevations to generate electricity. Hydropower projects encompass dam projects with reservoirs, run-of-river and in- stream projects and cover a continuum in project scale.

However, the effects of climate change on rivers and lakes which are major sources hydropower energy were highlighted in (Kiparsky and Gleick 2003; Mukheibir 2007; Covich 2009; Uramaand Ozor, 2010; Cherry, Walker, Fresco, andTrainor 2010; Renwick, Mladenov, Purdie, McKerchar, Jamieson, D. 2010; Beilfuss 2012; Hamudu, Tumbo, Kalumanga & Yanda2012; Kaunda and Mtalo 2013; and Department of Energy 2013). Any change in natural water circle caused by climate change will have impact on power generation. This is both a challenge and an opportunity in areas where there will be shortage of water (low level as rivers) and in areas where flooding will occur because of rivers overflowing their banks (Bariweni, Tawari and Abowei 2012; Kabat and Schaik 2003; Douglas, Alam, Maghenda et.al. 2008; and Miroslav Marence 2014).

In this paper, we reviewed the challenges of gathering, processing and analysing climatic data as it affects sustainable production and supply of electricity from hydropower energy. We also discussed how big data analytic tools are being applied in some climatic-change projects and also in sustainable/renewable energy projects.

2. Sustainable and Renewable Energy

Pacheco (2013) define sustainability as a balance in resource consumption and effortless environment integration. Thus, demand on certain resource does not diminish its supply capacity as there is assurance of its continuous existence in abundance.The resource therefore has capability of renewing and replenishing itself.

In Lemaire (2004), sustainability energy is described as the "form of energy got from non- exhaustible resources, and which serves the needs of the present without compromising the ability of future generations to meet their needs".Sustainable energy involves massive resource scaling, energy efficiency, renewable and has no long-term damage effect to the environment (Tester, Drake et. al 2005).

Renewable energy is "the use of energy from a source that does not result in the depletion of the earth's resources whether this is from a central or local source" (Lemaire, 2004).Renewable energy is therefore derived from natural processes such as the Sun, heat deep generated within the earth, and the earth massive water bodies (oceans, rivers, lakes and rainwaters). Six most important sources of renewable energy include Bioenergy, Direct Solar, Geothermal, Hydropower, Ocean energy and Wind energy (SSREN, 2012).These sources of energy can supply electricity, thermal energy and mechanical energy, andproduce fuels able to satisfy multiple energy service needs. According to Sustainable Energy for All (2014), energy from renewable resources makes up about 15% of the global energy mix.

(i) Human causes include burning fossil fuels, cutting down forests, and developing land for farms, cities, and roads. These activities all release greenhouse gases into the atmosphere.

(ii) Natural causes include changes in the Earth's orbit, the sun's intensity, the circulation of the ocean and the atmosphere, and volcanic activity.

3. Climate Change

Climate change is a long-term shift in the statistics of the weather (NOAA National Weather Service, 2007). Climate change is a real and urgent challenge that is already affecting people and the environment worldwide (Gonçalves-Moreira and Shikui 2014). .

According to Tarpet. al. (2014), analytical framework called Systematic Analysis of Climate Resilient Development (SACRED) that integrates comprehensive biophysical and economic analysis was proposed by UNU-WIDER and its external partners. SACRED analyses the effects of climate change based on critical factors such as hydropower output, agricultural yield, water supply/demand balance, and costs of maintaining infrastructure and other installed

capital. Using SACRED,critical infrastructure with associated uncertainties in climatic parameters could respond to robust adaptation strategies.

A way out is effective climate data monitoring, gathering and predictive analysis. Big data technique scan best be used in this direction since climate data are largely unstructured, occur frequently, required huge amount data storage and describe factual weather (Orts & Spigonardo, 2014).

4. Big Data

With new ideas and technology coming up almost on daily basis, datasets are multiplying in heterogeneous nature, and therefore newer and better measuring/analytic tools are required. Datasets (e.g. database of email addresses, telephone numbers, social media data, power consumption, climatic data etc.) which hitherto look like mundane and irrelevant to businesses are now considered critical to the survival, growth and prosperity of modern day organizations. These data are large, could be structured or structured and occurred on a minute by minute basis. Thus evolved the concept of Big Data which deals with the 4Vs; high-Volume, high- Velocity, high-Variety and high-veracity information sets that require new forms of processing to enable enhanced decision making, insight discovery and process optimisation (Laney 2012).

Big Data requires the use of a new set of tools, applications and frameworks to process and manage the data. Data analysis techniques involving Big Data include visualization,predictive, prescriptive and descriptive analytics. Visualization is the presentation of data in pictorial or graphical formats for quick and easy interpretation and analysis. Predictive analytics helps model and forecast what might happen. Prescriptive analytics seeks to determine the best solution or outcome among various choices, given the known parameters.Descriptive analytics aims to provide insight into what has already happened. Big Data is being applied in several areas like business intelligence, health informatics, agriculture, weather forecasting, renewable natural resources, green IT etc. In Davis (2013), the following applications illustrate the application of big data:

(i) Traffic Pattern:-Neflixuses big data built on the scalable cloud architecture which enable it to analyse traffic patterns across multiple device-types an-

dacross different global locations to improve the reliability of video streaming and plan for growth.Netflixbig data technique can also analyse and predict customer's viewing habits and stated preferences to certain products.

(ii) Pricing:- Netflix uses big data to gather and analyse information on each user (consumer / customer) to know how much they will to pay for a particular service or goods. Here, VRA/GRIDCO/PURC can use Neflix to determine the price per unit of electricity in Ghana.

(iii) Retail Habits:-Target uses big data technique to analyse a wealth of customer data andpredict their future purchasing habits. For example in universities, increase in students' admission rate or increase in programmes being offered might lead to additional demand on electricity consumption. Another example where this technique could be appropriate utilised is within domestic households where the number of inhabitants and household gadgets fluctuates.

(iv) Politics:-In most political climes, political campaigns, policy advocacies, socio- governmental engagements and opinion polls have migrated to the social media platforms such as Twitter, Facebook, Instagramand online blogs. Successive candidates and government officials are using these tools to promote themselves and their agenda. Citizens' reactions and response comes in zerrabytesof data. Big Data tools such as Hadoop,NoSQL,Jaspersoft BI Suite, Pentaho Business Analytics,Karmasphere Studioetcwere deployed to analyse these arrays of data.

(v) Weather:-WeatherSignal is a big data application that works by manipulating the sensors in Android devices to map atmospheric readings like air temperature, precipitation, annual and seasonal runoff. Most handheld mobile communication devices weather monitoring systems such as the barometer, hygrometer (humidity), ambient thermometer andlight meter. According to (Davis 2013), "the prospect of millions of personal weather stations feeding into one machine that will average out readings is exciting, and one that has the potential to improve forecasting".

(vi) Medical Diagnostic Analytic:- Big Data technique is also being used in predicting heart diseases as showed by IBM-Apache Unstructured Information Management Architecture (UIMA). Big data analytics has the capacity for drawing inferences from large database of heterogeneous data. The UIMA extracts known signs and symptoms of heart failure from electronic health records.

IBM has developed a big data technique refer to as The Spatio-Temporal Epidemiological Modeler (STEM) to examine local climate and temperature to determine correlations with occurrence of malaria across different locationsto predict the location of future malaria outbreaks. According to Galvez, J. (2013), "changes in climate have affected impact the geographical spread of diseases like malaria".

(vii) Roambi:-People ofoften downplay that decision making could be made on data-driven mobile systems. Data can now be manipulated using smartphones as basic business tools. On- the-go decisions could be made on smartphones just by accessing andanalzying same business data as if one is in the office. Roambiis the technique designed in mobile system to enable users interact, share and present information from smartphone perspective.

(viii) Esri ArcGIS:-Esri ArcGIS, as the name implies, is a Geographic Information System (GIS) that makes it easy to create data-driven maps and visualizations.

(ix) Zaloni Bedrock:-Zaloni Bedrock, the process is automatedHadoop data lake in a cost- effectiveand scalable way.

(x) Tamr:-Tamr is a data-connection and machine-learning platform designed to make enterprise data as easy to find, explore, and use as Google.

5. Big Data and Climate Change

Because the world is considering climate change and its side effects on socio-economic and environmental changes, leaves much to be desired on every country to wake up and respond to the general call by international bodies such as the United Nations to use innovative tools such as Big Data Analytics and Data-mining Technologies to extract useful information to harness and sustain sources of renewable energy.

The BigData Climate Challenge, hosted by Global Pulse to support the UN Secretary- General's 2014 Climate Summit, received submissions from 40 different countries at the close of the Call for Submissions (Cornish2014). There was a momentous response to this call leading to a convention of world leaders from government, finance, business and civil society to catalyse climate change action and to unearth data-driven climate solutions (Cornish2014). The Big Data Climate Challenge became one of the major discussions during the UN Summit on Climate Change which took place in September 2014 at the UN Headquarters in New York.

The extent to which the Big Data climate challenge hype went across also lead to researchers using of Big data analyticsin different ways to handle socio-economic and environmental challenges. Issues of interest include solar

power, emissions, public health, disaster management, renewable energy, biodiversity, green data centres etc. Some countries in Africa, Asia, European and Middle East, Latin America, and even Small Island Developing States(SIDS) submitted projects(Cornish2014). West Africa Countries were however absent in the list ofcountries in this all but important project. Consequently there is huge interestabout how big data can be used to model the environmental effects of climate change.

Lawrence (2012) suggested the use ofcomputing and big data analytic tools tocompute and analyse climate predictability and vulnerability.Keeso (2014) reviewed the application ofbig data analytics collaborative partnerships and business model innovation and asserted that "big data will become an integral element of environmental sustainability".

6. Big Data application in Sustainable and Renewable Energy

Michelangelo Ceci 2 & NunziatoCassavia, et.al. (2014) proposeda Virtual Power Operating Centre (Vi-POC), where data (e.g. user consumption patterns & profiles, climate/weather) with big data characteristics (high rate, heterogeneous, large, factual) could be gathered and analyse for effective energy production from renewable sources and power plant efficiency.

Krioukovet. al. (2011)proposed data analytic framework to model and analyse the variableness of many renewable energy sources. The result obtained revealed that supply-following job schedulers yield 40-60% better renewable energy penetration than supply-oblivious schedulers based on their IDC analytic simulations. Likewise, Arvizu (), proposed the use of big data to find retrofit opportunities in renewable energy technologies.

Paul English (Jan 01 2013) in the EMC 2 report observed that "the ability to forecast energy generation in real-time is vital for renewable industry".Aweb-based 3-TIER architecture with capability to undertake real-time supply-demand review and prediction was proposed. Experts' knowledge and skills were modelled using big data techniques while real-time data feed with associated analytics were used to forecasts energy production capability of renewable sources per time.

In South Korea big data technologies were deployed to sustain her energy plan from renewable and environmental sources. Distributed computing platforms that can share data and generate value for the effective use of renewable energy production was put in place. Thus enhancing its data warehousing and data mining capabilities for effective energy policy formulation, implementation, monitoring, and evaluation, and boost her sustenance of uninterrupted energy generation, transmission and distribution to consumers (Hyun Baek & Sun-Kyoung Park; 2015).

7. Conclusion

Big Data requires the use of a new set of tools, applications and frameworks to process and manage the data. From this trend, the capacity of data storage has been on increase, and today with available cloud infrastructure, one can store unlimited amounts of data. Again today Terabytes and Petabytes of data is being generated, captured, processed, stored, and managed using huge servers that require and dispense enormous amounts of energy.

This paper looks at some Big Data Climate change innovations that are taking place in some parts of the world as against the development of West African region. The region is endowed with so many natural resources (rivers, lakes, solar energy, etc.) and should not be left out in

the great efforts to explore innovative measures using big data analytics to sustain its resources caused by climate change and consequential effects.

The correct application of big data analytics could benefit the renewable energy business particularly in Ghana and the entire West African region.

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