Global Scientific JOURNALS

GSJ: Volume 9, Issue 10, October 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

Title: *"Effect of Hydropower Plant Projects on Socio-Environmental Sustainability and Development in Rwanda: Case of Rubagabaga Hydropower Ltd"*

Author: David BUCYIBARUTA **Supervised by Dr Jean Claude MUTESI**

ABSTRACT

The objective of this study was to investigate the socio-environmental impact of hydropower projects in Rwanda with a case study of Rubagabaga hydropower ltd operating from Nyabihu district. The primary aim of the research was to reflect on the problem that call for the conduction of the present study and wanted to answer the following research questions through empirical literature with subjective theories. It was therefore guided by examining the impact of socio-economic and environment hydropower plant in Rwanda, identify the challenge hydropower plants face in Rwanda and finally investigate relationship between hydro powers and their socio-economic impact in Rwanda? In this research, qualitative and quantitative research design based on statistical data of the research that was used with quantitative and qualitative methods. Questionnaires and interviews were used to collect data. The target population of this study was made up of 227 participants including 143 respondents all from ten different villages surrounding the Rubagabaga plant in Nyabihu District. From this population. The collected data was analyzed using descriptive and correlation analysis and tables those were interpreted to confirm or deny the relevance of the main and specific objectives. Based on results from table no.16 demonstrates that the beta= 0.397 with the t value of 2.333 and the p value of 0. 021.Since the p value is less than 0.05, researcher rejected the null hypothesis and considered it alternate. There is a strong positive relationship between environmental assessment of hydropower plant project and socio-environmental sustainability and development. In a nutshell, the researcher has rejected the null hypothesis and considered its alternate. In fact, Community structure and dynamics has positive influence on socio-environmental sustainability and development. The table no.16 shows that beta= 0.341 with the t value of 2.668 as the p value was 0.009. Since the p value is less than 0.05. Therefore, researcher rejected the null hypothesis and considered it alternate. According to the table no.21, the changes on community structure and dynamics of hydropower plant project causes the increase of 0.341 (34.1%) of the socio-environment sustainability and development. The ration of beta modal results for the t value expressed t=2.66 hence the probability value is significant on socio-environment sustainability and development noting that sig.=0.009. Carefully, the researcher has rejected the null hypothesis and considered its alternate. With this in mind, community structure and dynamics has positive influence on socio-environmental sustainability and development. The table no.16 has shown beta= 0.478 with the t value of 4.543 as the p value was 0.000 which is less than 0.05. According to the table no.21, the changes on government policies, stability and support of hydropower plant project causes the increase of 0.478 (47.80%) of the socio-environment sustainability and development. The ration of beta modal results for the t value expressed t=4.54 hence the probability value is significant on socio-environment sustainability and development noting that sig.=0.000. All things considered, the researcher has rejected the null hypothesis and considered its alternate confirming that government policies, stability and support of hydropower plant project has positive effect on socio-environmental sustainability and development. Based on the research results, the researcher recommends the following: There is a need in encouraging projects proposals reflecting on environmental assessment and projects funding strategies should be renewed. Due to the fact that this type of energy requires a flexible form of technology, there is a need in investing in capacity of water amounts

and run of rivers. However, the way water resources are treated can also reflect on the amount that is required to produce a certain amount of energy. The future of hydropower plants might be doubted on while there is a restriction put on youth that they should put their effort in inventing new technologies and sources of power that can alternate with the existing ones. Therefore, there is a need in involving young people in exploring other types of power and provide adequate trainings.

INTRODUCTION TO THE STUDY

No water, no life on earth. However, freshwater resources are limited and unevenly distributed by season or location across the world. The availability of adequate quantities of water with the appropriate quality is one of the fundamental requirements for socio-economic development. In the past, the main sources of domestic and industrial water have been aquifers. Today, many of these are now overused and their rate of recharge is far less than what is extracted. In this regard, one of the most efficient ways to manage and make profit from water resources for human needs is to construct hydropower plant project that create socio economic and environmental dimensions for the human sharing and distribution.

Ancient Greeks used wooden water wheels to convert kinetic energy into mechanical energy as far back as 2,000 years ago. In 1882 the first hydroelectric power plant was built in the United States using a fast-flowing river. Humans in time began creating dams to store water at the most convenient locations in order to best utilize power capacity. Additional engineering and structural changes have followed, providing for a much more complicated process in designing a hydroelectric power plant.

The recent development of large hydropower plants in countries like China and Brazil has also stimulated debate about the economic (Ansar t al., 2014), social (Jackson and Sleigh, 2000; Tilt et al., 2009), and environmental (Fearnside, 2006, 2015) effects of these projects. Economic impacts could be positive (e.g. higher income, better infrastructure) if the electricity revenues are shared with the local communities (Koch, 2002), or negative, if local agents absorb the costs associated with hydropower development (e.g., road repairs due to heavy truck traffic (Newell and Raimi, 2015), loss of productive agricultural and forest land (Duflo and Pande, 2007), and reduction of fishing resources (da Silva Soito and Freitas, 2011)). For example, in the case of irrigation dams in India, a study by Duflo and Pande found that agricultural production increased and rural poverty declined in districts located downstream from the dam, but rural poverty increased in the district where the dam was built. Furthermore, with the implementation of high-tension transmission lines, electricity can be transmitted thousands of kilometers away from the generating plant, meaning local communities may not directly benefit from increased electricity supply (Severnini, 2014).

Rwanda has experienced and endured energy crisis in the last three decades and has begun to make giant strides and significant improvements in electrification for the past few years, because of its vision, policies, and implementation strategies and plans. Rwanda has more than doubled the capacity of its 100MW electricity generation in 2010 to 216MW in 2017 making 42% of the target generation (512 MW), with universal access by 2023/24 which satisfies 100% of the population reliably and sustainably (EUCL, 2018). Energy of any kind is a must have in the current world, and with the green revolution people tend to be migrating to using renewable energy to stop environmental degradation. In the past, people in Rwanda were using charcoal, firewood, paraffin etc which were not environment friendly and definitely came with a cost. Today, governments have introduced green energy through renewable energy where clean energy is produced and used without having to degrade the environment including the introduction of hydro-energy among many others.

In 2017 the installed generation capacity in Rwanda was 216 MW of which 57.8 MW was thermal plant most of it leased and operating on imported petroleum fuel. The potential to generate electricity economically with local resources including, hydropower energy from many others has however, been estimated to total around 1,613 MW. The country is therefore, utilizing less than 10% of the locally produced electricity, excluding a substantial solar resource, while suffering a large foreign outflow.

1.2 Statement of the problem

Rwanda's post-conflict recovery resulted in a strong growth in demand for energy. But until 2005, the country suffered from acute shortage of electricity supply, expressed by severe load shedding. The supply shortages and unreliability raised costs of doing business, and simultaneously harmed the prospects of attracting new investment. The country's electricity generation plants (mainly diesel) had insufficient capacity and suffered from insufficient maintenance, while the hydropower generation had been constrained by regional drought that had also affected Kenya, Tanzania and Uganda, leaving Rwanda with no option of sourcing electricity from its neighbours (2003-2005). In addition, a rather dilapidated transmission and distribution network caused technical losses of around 30%. By 2008, the electricity company had only 109,000 households connected to the grid (RURA, 2008), almost all in the urban area of Kigali, with almost no connections in the rural areas, (Access to Energy in Rwanda, 2014).

The electric power supply is significantly inadequate and 47% of the entire population is gaining access to electricity and Nyabarongo I Hydropower Plant give 12.8% to total Rwanda installed capacity. Considering the current shortfall in electricity supply, power generation is set to grow to over 563 MW from its current capacity of 224.6 MW. Rwanda's major Rivers has proven 333 potential sites for Micro-hydropower countrywide. Opportunities exist in Micro and Small Hydropower projects and shared regional hydropower projects in East Africa (EAC) Partners. A couple of micro and mini, small Hydropower Projects are currently under construction. The largest domestic hydropower project is Nyabarongo I, with an installed capacity of 28MW, (Rwanda Least Cost Power Development Plan, 2019-2050).

In response to the above situation, the Rwandan Government has launched a plan to increase accessibility to rural areas such as the development and upgrading of micro-hydropower (MHP) village electricity mini-grids in cooperation with donors (FDRE 2017). As part of the National Electrification Program (NEP), community-based hydropower plants are being explored as a viable means to harness the country's vast hydropower potential and to sustainably transition from conventional sources of energy into modern energy services and to extend the access to and availability of renewable energy to all community member with attention to vulnerable members like women (FDRE 2017). However, several obstacles may affect the long-term feasibility of community-based hydropower plants such as poor institutional capacity, lack of coordination and inadequate implementation (Sovacool et al. 2011). In addition, while inherent injustices related to the consumption and production of large-scale carbon intense energy systems such as environmental degradation or air pollution are being widely discussed (see e.g. McCauley 2018), low-carbon energy systems in the global south such as micro solutions have new and different justice propositions that need attention.

Diverse power relations within the socio economic and environmental dimensions have negatively as well as positively affected an equal distribution of benefits from micro energy especially in the context of the global south (Nightingale 2011). It is often assumed that electrification primarily benefits society and environment as they are the ones who are responsible for most of the activities in place (Cecelski 1995; Winther et al. 2017). This assumption potentially swells distinct differences in terms of energy needs which produces different outcomes for both aspects and are not fully reflected in energy justice (Bell 2016).

1.3 Objective of the study

This study focused on the main and specific objectives.

1.3.1 General objective of the study

The general objective of this study was to investigate the effect of hydropower plant projects on socio-environmental sustainability and development in Rwanda.

1.3.2 Specific objectives of the study

The following specific objectives were formulated to guide the study:

1. To establish the effect of Environmental assessment of hydropower plant project on socio-environmental sustainability and development in Rwanda.
2. To investigate the extend of Community Structure and Dynamics of hydropower plant project on socio-environmental sustainability and development in Rwanda.
3. To establish the effect of Government policies, stability and support on socio-environmental sustainability and development in Rwanda.

1.4 Research Questions

The research questions are important as they keep the researcher interested and focused on a specific topic. They define what sorts of small questions the researcher needed to ask. They guide what sorts of reading the researcher might need to do or data he/she might need to gather. The following are the research questions that was focused on:

i. To what extend does Environmental assessment of hydropower plant assist in socio-environmental sustainability and development in Rwanda?

ii. How does Community Structure and Dynamics of hydropower plant help in socio-environmental sustainability and development in Rwanda?

iii. What is the contribution of existing government policy, stability and support in socio-environmental sustainability and development in Rwanda?

LITERATURE REVIEW

2.1. Concept of variables

Concept of Variables are attributes of an object of study. Choosing which variables to measure is central to good experimental design. Variables in the current research simply are phenomenon that the researcher is trying to measure in some way. Concept of variables is defined as a methodology wherein research is conducted by observing and analyzing already present information on a given topic

2.1.1. Hydropower plant project

Humans have been shaping the earth's landscape since the beginning of their existence. In the same way that trees are cut down to make way for roads, hydropower plants have been built to manipulate and divert water bodies for human benefit (Bayeh, & Endalcachew, 2015). The scale of hydropower projects has evolved along with the scale of human development and industry (Bayeh, Endalcachew, 2016). In this regard, developing communities face a different level of cost benefit analysis than developed communities when it comes to large infrastructure developmental projects. Having a variety of socio-economic status within a small geographic area presents opportunity for disparity in impact based on environmental changes (Bickerstaff, Karen, Walker, & Bulkeley, 2013).

2.1.2. Socio-environmental sustainability and development

The socio-environmental sustainability and development include increase in access to public goods and services, domestic security, and energy security. Externalized costs and benefits must be weighed to determine the overall impact of a developmental project in the social and environmental realm. Where economic incentive exists; typically, social benefits exist as well. Hydropower plant projects have the potential to manipulate rivers to benefit local populations. Flood protection is an important service that allows communities to live comfortably along a river without fear of volatile flood patterns (Yuksel, 2009). In some scenarios, hydropower plants provide increased water supply for arid populations and increase livelihood value (Workman, 2009). In many scenarios, they are used for hydroelectric production supports other uses such as irrigation contributing to occupations in the agricultural industry, tourism, research and study with service development (Workman, 2009).

2.1.3. Environmental assessment

An environmental impact assessment (EIA) is an assessment of the possible impact - positive or negative - that a proposed project may have on the environment, considering natural, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the ensuing environmental impacts to decide whether to proceed with the project. As a policy instrument the EIA ensures that the environmental implications of a project are anticipated and minimized. They are applied for all types of projects like infrastructure development, and also for hydropower projects (Standal & Winther, 2016).

2.1.4. Community Structure and Dynamics

Communities are complex entities that can be characterized by their structure (the types and numbers of species present) and dynamics (how communities change over time). Understanding community structure and dynamics enables community ecologists to manage ecosystems more effectively. Foundation species may physically modify the environment to produce and maintain habitats that benefit the other organisms that use them (Becker, 1994).

2.1.5. Governmental policies, stability and support

The Guideline aims to provide policy guidance to the agencies responsible for overseeing the implementation of investment projects in the hydropower sector as well as to inform and encourage project developers/investors to be aware of the Government policy toward achieving sustainable development. One of the challenges in creating public-private partnerships is for governments to create an appropriate environment to attract private investment. When governments act in their sovereign role as guardians of the public welfare, they are essentially providers of public goods and services, which in turn may be delivered through public or private channels. When governments implement policy decisions and resolve political conflicts through the legislative and regulatory process, their role is objectively to carry out the will of the body politic (Barros, et al. 2011).

RESEARCH METHODOLOGY

3.1. Research design

Christensen (2011) defines research design as the out plans or strategies specifying the procedures to be used in looking for an answer to the research questions and objectives. It specifies such things as how to collect and analyze the data. With reference to the purpose of this study on socio- economic and environmental impacts of hydropower plant projects in Rwanda. The present research involved qualitative and quantitative research design deemed necessary to the description of the data that was collected. According to Ross (2005), quantitative research method is used when the research problem is a description of trends or an explanation of the relationship among variables. The same author argues that descriptive research determines and reports on the way things are and collects data to test hypotheses or answer questions about the current status of the subject study. With reference to the above definitions, this study was a descriptive study because it describes the socio-economic and environmental impacts and hydropower in Nyabihu District. Moreover, the researcher used descriptive design because this study intends to explore the relationship between variables studied.

3.2. Sampling design

This sampling frame consisted a sample size and sampling techniques used in the study.

3.2.1. Population of the study

This research was targeting mainly the population surrounding Rubagabaga hydropower plant located fron Shyira sector in Nyabihu district. According to Cooper and Schindler (2010), a population is the total collection of elements about which we wish to make some inferences. It is a group of individuals, objects or items from which samples are taken for measurement.

3.2.2. Sample Size Determination

The determination of the sample size of this research was indicated as 143 basing on Solvins' formula as stated below and declares that for a population of 227 individuals or households, the sample can be 143 as sample size. Therefore, the sample size was 143 as the total sample made of people from the local community with a close relationship with Rubagabaga hydropower plant project located in the district.

Given:

n = Sample size

N =Study population

e= margin of error which determined based on the confidence level (expressed in percentages).

For the purpose of this study, the sample is calculated as follows.

N= 227

Confidence level=95% thus, e=0.05

$$n = \frac{N}{1 + N(0.05)^2}$$

Then $n = \frac{227}{1+227(0.05)^2}$ =**143**

3.2.3. Sampling technique

Simple random sampling technique was used because it allows every member of the population to have an even chance and likelihood of being selected in the sample. Therefore, the selection of respondents completely depends on chance or by probability. The researchers assume that they can use their knowledge of the population to judge whether or not a particular sample was representative (Wallen, 2006). In this study, simple random sampling was applied to all villages surrounding the hydropower plant.

3.3 Instruments of data collection

In data collection the researcher used questionnaires and interview. Questionnaires and interview was translated and transcribed from English to Kinyarwanda and administered to the respondents to facilitate the respondents answer to the questions. The researcher also used library and internet-based method as instruments for data collection related to socio- economic and environmental impacts of hydropower plant. The cause of using different methods, commonly known as triangulation, is to get rich data enabling the researcher to properly achieve the objectives.

3.4 Data collection procedures

As mentioned above, data collection procedures reflected as questionnaires give the respondents an opportunity to answer in their own way that works for them. However, the majority of the questions were multiple-choice, closed-ended questions based on a five-point Likert scale that are namely 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Certain means were calculated from the results in order to make a comparison between different aspects possible.

3.5 Reliability

According to Saunders *et al*., (2007), reliability means the degree to which the data analysis procedures and data collection techniques yield consistent results. Reliability is an indicator of consistency, i.e., an indicator of how stable a test score or data is across applications or time. In this study, the measure was assessed to produce similar results consistently then since the measures gave the same “results.” A measure can be reliable without being valid.

3.6 Validity

Ochieng (2009) argues that, for a study to be real meaning, it has to apply valid and reliable instruments. Before actual research to be done, pre-test was done, validity and its reliability were established.

Validity means ascertaining the accuracy of the instruments by establishing whether the instruments focus on the information they are intended to collect. In order to ascertain face validity, the instruments were constructed and handed to the supervisor for constructive criticisms. Thereafter, they were revised according to the supervisor comments.

3.7 Data analysis

The collected raw data was inspected to ensure it is complete and accurate. Questionnaires was organized and classified according to the study objectives. Qualitative data was classified and coded into themes and concepts for analysis based on objectives of the study. This study employed Karl Pearson’s coefficient of correlation. The Karl Pearson’s coefficient of correlation is a method which was used for measuring the degree of relationship between two variables. Since the symbol used to identify Pearson’s Correlation Coefficient is a lower case “r”, it is often called “Pearson’s r”. This coefficient assumes that there is linear relationship between the two variables that the two variables are casually related which means that one of the variables is independent and the other one is dependent; and a large number of independent causes are operating in both variables so as to produce a normal distribution.

3.8 Ethical considerations

The goal of ethics in research was to ensure that no one is harmed or suffers adverse consequences from research activities (Cohen et al, 2007). The researcher strictly observed the following: Confidentiality: The participants were guaranteed that the information they provided would not be made available to anyone who is not involved in the study and they remain confidential for the purposes it is intended for; Permission: The researcher seek a permission letter from University of Kigali (UoK) which was presented to the school authorities as an insurance of academic purpose; Informed consent: The prospective research participants were fully informed about the procedures that involved in the research and was asked to give their consent to participate; Anonymity: The participants were remained anonymous throughout the study, even to the researcher so as to guarantee their privacy.

PRESENTATION, ANALYSIS AND INTERPRETATION OF FINDINGS

4.1 Introduction

In this chapter four, the researcher ha interpreted the findings in a systematic way. The main objective of the study aimed at evaluating the effects of hydropower plant on socio-environment sustainability and development in Rwanda. Supportively, the study has worked on specific objectives establishing the effects of environmental assessment of hydropower plant project, the extend of community structure and dynamics of hydropower plant project, the effect of government policies, stability and support on socio-environment sustainability and development in Rwanda. The data obtained from field has been presented in form of qualitative and quantitative which allowed the researcher to give accurate explanations of the findings in general.

4.2 Descriptive statistics

Using descriptive statistics was helpful in terms of simplifying large amount of data in an easy and sensible way. It is very easy to summarize the data and consider a small number of variables and data which easy the interpretation. Hayes & Smith (2021) define descriptive statistics as the coefficient that help a researcher to summarize the data by breaking them into sections indicating the mean. It is the best easy way to collect, analyze and interpret the data and measure the variability. While describing the descriptive statistics, I have put my focus on interpreting the mean, skewness, and kurtosis to know how the data I have are distributed in form of peaks, substantially distributed, or making a flat distribution.

Table 1: Skewness and Kurtosis of Environmental assessment

Descriptive Statistics							
	N	**Mean**	**Std. Deviation**	**Skewness**		**Kurtosis**	
	Statistic	**Statistic**	**Statistic**	**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
Ensure that decision makers consider the ensuing environmental impacts to decide whether to proceed with the project	143	4.9580	.23359	-6.172	.203	41.519	.403
Ensures that the environmental implications of a project are anticipated and minimized	143	4.9790	.14382	-6.756	.203	44.262	.403
Identify, evaluate and mitigate the environmental effects of a proposed project prior to major decisions and commitments being made	143	4.9860	.11785	-8.365	.203	68.943	.403
Elaborates mitigation and monitoring measures	143	4.9580	.23359	-6.172	.203	41.519	.403

Mean Range between 4.95 and 4.98 thus a small difference between factors. This factor to be considered

Kurtosis: 41.59 – 68, all positive meaning that data is heavily tailed

Skewness: -8.36 to -6.75, indicating substantial distribution

Table 2: Skewness and Kurtosis of Community Structure and Dynamics

Descriptive Statistics							
	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Community Structure and Dynamics of hydropower plant made local community Health, well-being and vitality	143	4.9720	.20363	-8.038	.203	69.180	.403
Community Structure and Dynamics of hydropower plant made Cultural well-being	143	4.9650	.18434	-5.117	.203	24.527	.403
Community Structure and Dynamics of hydropower plant provided Community stability	143	4.9860	.11785	-8.365	.203	68.943	.403
Community Structure and Dynamics of hydropower plant facilitated Services and infrastructure	143	4.9930	.08362	-11.958	.203	143.000	.403
Community Structure and Dynamics of hydropower plant facilitate Education and training	143	4.9860	.11785	-8.365	.203	68.943	.403

Mean Range between 4.96 and 4.99 thus a small difference between factors. This factor to be considered
Kurtosis: 24.52 – 143, all positive meaning that data is heavily tailed
Skewness: -11.78 to -5.11 indicating substantial distribution

Table 3: Skewness and Kurtosis of Government policies

Descriptive Statistics							
	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Provide policy guidance to the agencies responsible for overseeing the implementation of investment projects	143	4.9860	.11785	-8.365	.203	68.943	.403
Inform and encourage project developers/investors	143	4.9720	.20363	-8.038	.203	69.180	.403
Be aware of the Government policy toward achieving sustainable development	143	4.9860	.11785	-8.365	.203	68.943	.403

Mean Range between 4.97 and 4.98 thus a small difference between factors. This factor to be considered

Kurtosis: 68.94 – 69.18, all positive meaning that data is heavily tailed

Skewness: -8.36 to -8.03, indicating substantial distribution

ix

Table 4: Skewness and Kurtosis of hydropower plant project on socio-environmental sustainability and development

Descriptive Statistics							
	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
The hydropower plant developed Public Acceptance to Change and learning system	143	4.9510	.24692	-5.557	.203	33.660	.403
The hydropower plant influenced Infrastructure development and job creation	143	4.9790	.14382	-6.756	.203	44.262	.403
The hydropower plant subsidized Access to Electricity Resources and Electricity Quality	143	4.9860	.11785	-8.365	.203	68.943	.403
The hydropower plant promoted the Tourism	143	4.9650	.18434	-5.117	.203	24.527	.403
The hydropower plant influenced Health and Safety	143	4.9650	.21924	-6.966	.203	52.623	.403
The hydropower plant provided Air Quality	143	4.9580	.20120	-4.618	.203	19.597	.403

Mean Range between 4.95 and 4.98 thus a small difference between factors. This factor to be considered
Kurtosis: 19.59 – 68.94, all positive meaning that data is heavily tailed
Skewness: -8.36 to -4.61, indicating substantial distribution

4.3. Test of Null Hypothesis Predicting the Effect of Objectives

Before concluding on the hypothesis, the researcher followed a scientific method to confirm if the hypothesis would be true. The table below demonstrated the degree to which the dependent and independent variables correlate indicated both standardized and unstandardized coefficients testing for the factors.

Table 5: Testing hypothesis by Coefficient of Hydropower Development

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Environmental assessment	3.012	1.291	.397	2.333	.021
2	Community Structure and Dynamics	2.843	1.066	.341	2.668	.009
3	Government policies, stability and support	2.590	.570	.478	4.543	.000

4.3.1. Environmental assessment of hydropower plant project has no positive effect on socio-environmental sustainability and development

x

According to the table no.21, Y= $\alpha+\beta_1X_1$ +ę and β=.397 projecting that the changes on Environmental assessment causes the increase of 0.39 (39.7.0%) of the socio-environment sustainability and development. The ration of beta modal results for the t value expressed t=2.33 hence the probability value is significant on socio-environment sustainability and development noting that sig.=0.021 since the value of p is less than 0.05, the researcher has rejected the null hypothesis and considered its alternate confirming that environmental assessment of hydropower plant project has positive effect on socio-environmental sustainability and development.

α: -Y Intercept

β: -Regression coefficient

I : -Socio-environnemental sustainability and development.

Sig. =0.000, t=2.33

$\beta_{\neq}$ 0: Reject Ho if $\beta_{1 \text{ is} \geq}$ α
Reject the Null hypothesis

4.3.2. Community Structure and Dynamics of hydropower plant project has no positive effect on socio-environmental sustainability and development

According to the table no.21, Y= $\alpha+\beta_1X_1$ +ę and β=.341 projecting that the changes on community structure and dynamics of hydropower plant project causes the increase of 0.341 (34.1%) of the socio-environment sustainability and development. The ration of beta modal results for the t value expressed t=2.66 hence the probability value is significant on socio-environment sustainability and development noting that sig.=0.009 since the value of p is less than 0.05, the researcher has rejected the null hypothesis and considered its alternate. In fact, Community structure and dynamics has positive influence on socio-environmental sustainability and development.

α: - Y Intercept

β: - Regression coefficient

I : - Socio-environnemental sustainability and development

Sig. =0.000, t=2.66

$\beta_{\neq}$ 0: Reject H1 if $\beta_{1 \text{ is} \geq}$ α
Reject the Null hypothesis

4.3.3. Government policies, stability and support of hydropower plant project has no positive effect on socio-environmental sustainability and development

According to the table no.21, Y= $\alpha+\beta_1X_1$ +ę and β=.478 projecting that the changes on government policies, stability and support of hydropower plant project causes the increase of 0.478 (47.80%) of the socio-environment sustainability and development. The ration of beta modal results for the t value expressed t=4.54 hence the probability value is significant on socio-environment sustainability and development noting that sig.=0.000 since the value of p is less than 0.05, the researcher has rejected the null hypothesis and considered its alternate confirming that Government policies, stability and support of hydropower plant project has positive effect on socio-environmental sustainability and development.

α: - Y Intercept

β: - Regression coefficient

I : - Socio-environnemental sustainability and development

Sig. =0.000, t=4.54

$\beta_{\neq}$ 0: Reject Ho if $\beta_{1 \text{ is } \geq} \alpha$
Reject the Null hypothesis

SUMMARY, CONCLUSION AND RECOMMENDATIONS

- **Effect of Environmental assessment of hydropower plant project on socio-environmental sustenance and development in Rwanda**: The p value was equivalent to 0.11 which is under 0.05. Meaning that p<0.05. Regression Model statistically strong and variables were significant
- **Investigating the Extent of Community Structure and Dynamics of hydropower plant project on socio-environmental sustenance and development in Rwanda**: The p value was equivalent to 0.000 which is under 0.05. Meaning that p<0.05. Moving forward, the regression model is observed as statistically strong and the variables are significant
- **Establish the effect of Government policies, stability and support on socio-environmental sustenance and development in Rwanda**: through a statistical significance the p value equivalent to 0.000 which is under 0.05. Meaning that p<0.05. As a simple observation, the regression model is observed as statistically strong and the variables are significant

Conclusions from the Study;

- **Effect of Environmental assessment of hydropower plant project on socio-environmental sustenance and development in Rwanda**: beta= 0.397 with the t value of 2.333 and the p value of 0. 021.Since the p value is less than 0.05, researcher rejected the null hypothesis and considered it alternate. There is a strong positive relationship between environmental assessment of hydropower plant project and socio-environmental sustenance and development
- **Effect of Community Structure and Dynamics of hydropower plant project on socio- environmental sustenance and development**: beta= 0.341 with the t value of 2.668 as the p value was 0.009. Since the p value is less than 0.05. Therefore, researcher rejected the null hypothesis and considered it alternate. There is a strong positive relationship between community structure of hydropower plant project and socio-environmental sustenance and development
- **Effect of Government policies, stability and support on socio-environmental sustenance and development**: beta= 0.478 with the t value of 4.543 as the p value was 0.000 which is less than 0.05. Therefore, researcher rejected the null hypothesis and considered it alternate. There is a strong positive relationship between government policies, stability and support on socio-environmental sustenance and development

Recommendations;

- Continuous efforts for both private and public sector and adequate care is given to existing energy infrastructure

- There is need for more project proposals on environmental assessment and project funding

- Further investigations to improve on the technology to prevent any negative environmental effects from such infrastructures such as water/air pollution

- Energy is key to socio-environment sustenance and development; therefore, effective risk mitigation measures should be put in place to avoid any backslides on the available energy

Further Research

- Future studies should be conducted to find out the effects of water shortage and rainfall distribution on hydropower plants energy production.

- To find out the effects of climatic instability water pollution on the production of sustainable energy in Rwanda.

- Referring to the population increase, future studies need to assess the effects of higher population increase on inadequate distribution of natural resources and electricity.

References

Abbasi, T. (2011). *Small hydro and the environmental implications of its extensive utilization.* Renewable and Sustainable Energy Reviews 15, p 2134-2143.

Abrate, T. (1999). *Water availability and data availability*. WMO policy and activity', in Enne,

Abson, D. & Termansen, M. (2011). V*aluing ecosystem services in terms of ecological risks and returns.* Conservation Biology, 25, p250-258.

AFDB (2013a). *Rwanda Energy Sector: Review and Action Plan*.

AFDB (2013b). *Rwanda-Scaling up Energy Access Project*.

Agarwal, & Bina. (2001). *Participatory Exclusions, Community Forestry, and Gender: An Analysis for South Asia and a Conceptual Framework*." World Development 29 (10): 1623–1648.

Baanabe, J. (2008). *Large scale hydropower, renewable energy adaptation and climate change and energy security in the East and Horn of Africa*. HBF.

Bacon, R., Besant-Jones, J. & Heirarian, J. (1996). *Estimating construction costs and schedules: experience with power generation projects in developing countries*. Technical Paper 325. Washington, D. C.: World Bank.

Bimenyimana, S., Asemota, G. N., & Li, L. (2018). *The state of the power sector in Rwanda: a progressive sector with ambitious targets*. Frontiers in Energy Research, 6, 68.

Brew-Hammond, A. (2010). *Energy access in Africa: challenges ahead*. Energy Policy 38, 2291–2301. doi: 10.1016/j.enpol.2009.12.016 CR (Construction Review Online) (2017). Rwanda Launches First Peat-Fired

Cecelski, E. (2006). *From the Millennium Development Goals towards a gender-sensitive energy policy research and practice: Empirical evidence and case studies*. Collaborative Research Group on Gender and Energy, Netherlands.

Cornwall, A. (2008). *Unpacking participation: Models, Meanings and Practices*. Community Development Journal 43 (3): 269–283.

EDCL. (2018b). *Electricity Access in Rwanda Quadrupled in the Last 7 Years as More Households Get Connected*.

EDCL. (2018a). *Electricity Access*.

EUCL (2018). *Incentives to Investors*. Energy Utility Corporation Limited.

GIZ. (2011). *Draft: Ererte Micro Hydropower Plant Handing Over*". Unpublished Internal Document.

GIZ. (2017a). *Energising Development Partnership – En Dev*. Country Project Ethiopia."

Hakizimana, J. D. K., and Kim, H.-T. (2016). *Peat briquette as an alternative to cooking fuel: a techno-economic viabililty assessment in Rwanda*. Energy 102, 453–464. doi: 10.1016/j.energy.2016.02.073

Hildyard, N. (2008). *Dam on the rocks: The flawed environmental of large hydroelectric dams The Corner House Briefing*. Dorset, United Kingdom: The Corner House.

International River Network (2004). *A Critique of the World Bank's Country Assistance Strategy for India, prepared by Ann Kathrin Schneider, International Rivers Network*.

Islar, M., Brogaard, S., & Lemberg-Pedersen, M. (2017). *Feasibility of Energy Justice: Exploring National and Local Efforts for Energy Development in Nepal*. Energy Policy 105: 668–676. doi:10.1016/j.enpol.2017.03.004.

Mayring, P. (2000). *Qualitative Content Analysis; Forum Qualitative Sozialforschung / Forum*: Qualitative Social Research, Vol 1, No 2 (2000)

McCauley, D. A., Heffron, H., Stephan, R. J., & Jenkins, K. (2013). *Advancing Energy Justice: The Triumvirate of Tenets*. International Energy Law Review 32 (3): 107–110.

Ngozwana, N. (2017). *Ethical dilemma in qualitative research methodology: Research's reflections*. International Journal of Educational methodology. Volume 4,issyue1,19-28.

Polkinghorne, D. E. (2005). *Language and meaning: Data collection in qualitative research*. Journal of counseling psychology, 52(2), 137-145.

Sovacool, B. K., S. Dhakal, O. Gippner, & Bambawale, M. J. (2011). "*Halting Hydro: A Review of the Socio-Technical Barriers to Hydroelectric Power Plants in Nepal*." Energy 36 (5): 3468–3476.

Tigabu, D. G. (2016). *Deforestation in Ethiopia: Causes, Impacts and Remedy*." International Journal of Development Research 4 (2): 2321–9939.

UN Women. (2013). *Advancing Gender Equality: Promising Practices*. Case studies from the

UNDP. (2016). *UNDP Support to the Implementation of Sustainable Development Goal*

Wittwer, G. (2009). *The Economic Impacts of a New Hydropower plant in South-East Queensland*. Australian Economic Review, 42(1), 12–23. doi:10.1111/j.1467-8462.2009.00506.x

Workman, J. (2009). *Dams Encyclopedia of Environmental Ethics and Philosophy*. (Vol. 1, pp.197-200). Detroit: Macmillan Reference USA.

Yuksel, I. (2009). *Hydropower plants and hydropower for sustainable development*. Energy Sources Part B-Environmental Planning and Policy, 4(1), 100-110.

Zelenakova, M., Zvijakova, L., & Purcz, P. (2013). *Small Hydropower Plant – Environmental Impact Assessment* – Case Study, 3(4).