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PRELIMINARY STUDY ON EFFECTS OF DIFFERENT PLANTING DEPTH ON THE GROWTH POTENTIALS OF *VITELLARIA PARADOXA* C. F. GAERTN

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Abstract

Plantation establishment of tree crops requires appropriate planting techniques, management of air, moisture and nutrient interaction in the soil. Proper planting of tree seedlings will eventually enhance growth of trees. This study, therefore, investigated effects of different planting depths on the growth potential of *Vitellaria paradoxa*. Twelve months old uniform seedlings of *V. paradoxa* were planted at different planting depths in Forestry Research Institute of Nigeria. The study consisted of five treatments of varying planting depth in Completely Randomized Design and replicated eight times at espacement of 5 m by 5 m. Seedlings heights, girth, numbers of branches and canopy widths were assessed monthly for 24 months. Data collected were subjected to descriptive analysis and Analysis of Variance (ANOVA). Analysis of Variance showed that there was significant difference ($P < 0.05$) among the planting depths in canopy width but no significant difference in shoots height, number of branches, and the girth. The highest mean shoot height (80.33 cm) was recorded for T_3 (25 x 15 cm) while T_1 (15 x 15 cm) had the least values of 55.8 cm. The number of branches and canopy width revealed that T_3 had the highest mean value (7.75) and (102.55 cm) respectively. *V. paradoxa* utilized plethora mechanism to acquire sufficient and required amounts of mineral nutrients for proper growth and development. It is, therefore, recommended that for appropriate growth potential of *V. paradoxa* on the field and its stability in the soil, the planting depth must not lower than 20 cm.

Keywords: Plantation establishment, Growth potential, *V. paradoxa,* Planting depth.

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1. Introduction

The Shea butter tree (*Vitellaria paradoxa* C.F Gaertn) which belongs to the family *Sapotaceae* grows widely in the savannah region of West African countries (Hall *et al.*, 1996). It is a deciduous dicotyledonous crop that has a gestation period varying from 15 to 20 years. It takes about 45 years to attain maturity but after this, it may continually produce Shea nuts for up to 200 years. The matured trees vary considerably in height with some reaching a height of over 14 m and a girth over 1.75 m (Yidana, 1994). It is recognized as a non-traditional export crop. The Shea tree is of high economic importance with high value attributed to its butter, obtained from dried Shea nuts, which is a ready source of fat in local diets (Lamien *et al*., 2007). Boffa (1999) described the butter to have characteristics similar to that of cocoa butter. It's use as a cocoa butter equivalent (CBE) in the manufacture of confectionery and as an important ingredient in pharmaceutical and cosmetic industries has greatly increased its global demand. It is appreciated for its skin healing and protective properties (Schreckenberg, 2004; Popoola and Norbert, 2001). Naturally, Shea tree grows and regenerates itself in the wild but it's slow and poor natural regeneration pattern due to long gestation period, impacts of bush fires and desertification have limited the domestication and genetic improvement of this crop. These limitations have necessitated the need for an alternative method of conserving this plants genetic resource outside the natural habitat (Bonkoungou, 2005).

Plantation establishment of tree crops require appropriate management of air and moisture interaction in the soil. This air and moisture relationship is dependent on proper planting of seedlings on the field. Proper planting of tree seedlings will eventually enhance growth of trees. AccordingHartmann*et al*. (1997) there are some factors that contribute to poor establishment of planted seedlings; planting too deep or shallow, under watering, over watering and over-mulching. Planting too deeply in compacted soil can lead to very slow root development and each of the above factors can lead to extensive tree death and poor growth after planting. If trees are thereby planted at the right depth and they are irrigated properly, the planting has a good chance of success. Therefore, in order to have a successful plantation of *Vitellaria paradoxa*, this study investigated the appropriate planting depth that canfavour the species growth potentials.

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2. Materials and Methods

The study was carried out at the Forestry Research Institute of Nigeria, Ibadan arboretum. Located on the longitude 07°23'18'' N to 07°23'43''N and latitude 03°51'20''E to 03°23'43''E (FRIN, 2015). Forty (40) uniform seedlings of *V. paradoxa* (Twelve months old) were collected from the silviculture nursery of FRIN and transplanted to the arboretum on 22nd day of July, 2016.Planting holes of 15 cm width of different depths were dung (Plate 1). The study thereby consisted of five treatments of varying planting depth in Completely Randomized Design and replicated eight times at espacement of 5 m by 5 m.

Where;

Treatments	Depth (cm)	Width (cm)
T_1	15	15
T_2	20	15
T_3	25	15
T_4	30	15
T_5	35	15

The following growth parameters were assessed monthly for twenty four months:

The heights of seedlings were measured from the root collar to apical bud using a graduated ruler. (Plate 1) while the girth of each seedling was measured at about 5 cm above ground level with the use of digital caliper (Plate 2). Numbers of branches produced by each seedling were counted and canopy widths of seedlings were measured with graduated ruler (Plate 3). Data collected were subjected to descriptive analysis and Analysis of Variance (ANOVA).

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Plate 1


Plate 2


Plate 3


Plate 4

Plate 1: Depth and Width Measurement of Planting hole
Plate 2: Measurement of Shoot height with Graduated ruler
Plate 3: Measurement of seedling girth with Caliper
Plate 4: Measurement of Canopy width with Graduated ruler

3. Results and Discussion

Study on growth and development characteristics of tree crops are important information for effective production and management of trees in the field or plantation. The depth at which trees are planted on the field has greater influence on the tree stability, growth and forms. At the end of 24 months of the study, Analysis of Variance showed that there was significant difference among the planting depths in

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canopy width but no significant difference in shoots height, number of branches, and girth (Table 1). Though, T_3 had the highest mean shoot height (80.33 cm) followed by T_4 (73.98 cm) while T_1 had the least values of 55.8 cm (Fig. 1). This is in consonance with Ruyssen (1957) who observed little variation in shoot height of *V. paradoxa* seedlings when planted at varying planting depth. In contrast, the value obtained for the shoot height within period of study were higher than what was observed (19 cm) by Breman and Kessler (1995) on 2 years old seedlings of *V. paradoxa* on the field in Cot d'Ivoire. The number of branches produced from each treatment revealed that T_3had the highest mean value (7.75) followed by T_1 (5.5) while the least values was recorded for T_2 (2.75) (Fig. 2). The value for canopy width was highest in T_3 (102.55 cm) followed by T_4 (95.98 cm) while T_1 (68.28 cm) was the least (Fig. 3). Figure 4 showed that T_1 (20.89 mm) had the highest girth followed by T_3 (19.68 mm) while the least was recorded for T_5 (15.9 mm).

The highest values of growth variables ascribed to T_3 could be attributed to availability of nutrients at the top soil. According to Morgan and Connolly (2013), growth and development of plants depend on mineral nutrients combination and concentration in the soil. It has been found that due to the relative immobility and restriction of nutrients in the soil at different depths, plants are constrained in obtaining an adequate supply of these nutrients to meet the demands of basic cellular processes (Jone and Ljung, 2012). Meanwhile, deficiency of any one of the nutrients could result in stunted growth or death of plant tissue. Plants are known to show different responses to different nutrient deficiencies and the responses can vary between species For example, soil profile that is deficient in P inhibits primary root growth, increase in lateral root growth and density is associated with N, P, Fe, and S deficiency while increase in root hair growth and density is associated with P and Fe deficiency (Hell and Hillebrand, 2001). Different mineral soil nutrients perform different functions in plant metabolism (Vance, 2001). Two classes of nutrients are considered essential for plants: macronutrients and micronutrients. Macronutrients are the building blocks of crucial cellular components like proteins and nucleic acids; as the name suggests, they are required in large quantities. Nitrogen, phosphorus, magnesium, and potassium are some of the most important macronutrients. Carbon, hydrogen, and oxygen are also considered macronutrients as they are required in large quantities to build the larger organic molecules of the cell; however, they represent the

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non-mineral class of macronutrients. These are commonly available in top and sub soil which ranges from 0 – 30 cm soil depth (Asinwa, 2018, Oyelowo, 2014).

Invariably, plant roots within this soil profile accessed more mineral nutrients for morphological developments. This implies that statistical difference in canopy formation and variation in mean growth of other parameters could be attributed to the efficiency of nutrient acquisition (Ferguson, 2010). For instance, the chemistry and composition of certain soils at certain level can make it harder for plants to absorb nutrients. The nutrients may not be available in certain soil depth, or may be present in forms that the plants cannot use. Soil properties like water content, pH, and compaction may worsen these problems. Also, some plants possess mechanisms or structural features that provide advantages when growing in certain types of nutrient limited soil depths. In fact, most plants have evolved nutrient uptake mechanisms that are adapted to their native soils and are initiated in an attempt to overcome nutrient limitations (Britto and Kronzucker, 2008). One of the most universal adaptations to nutrient-limited soil depths is a change in root structure that may increase the overall surface area of the root to increase nutrient acquisition or may increase elongation of the root system to access new nutrient sources (Britto and Kronzucker, 2008). These changes which are subjective to plant development can lead to an increase in the allocation of resources to overall root growth, thus resulting in greater root to shoot ratios in nutrient-limited plants (Lopez-Bucio, 2003).

Table 1: Analysis of Variance (ANOVA) for different Planting Depth on Growth Variables of *Vitellaria Paradoxa* within 24 months of study

Variables	SV	df	SS	MS	F-cal	P-val.
Shoot Height (cm)	Treatments	4	2176.560	544.140	0.649	0.631^{ns}
	Error	35	29340.120	838.289		
	Total	39	31516.680			

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Number of Branches	Treatments	4	17.600	4.400	0.755	0.562^{ns}
	Error	35	204.000	5.829		
	Total	39	221.600			
Canopy Width (cm)	Treatments	4	8900.026	2225.007	4.200	0.007*
	Error	35	18542.498	529.786		
	Total	39	27442.524			
Girth (mm)	Treatments	4	234.803	58.701	0.791	0.539^{ns}
	Error	35	2597.297	74.208		
	Total	39	2832.100			

*=significant at P<0.05
ns =not significant at P>0.05

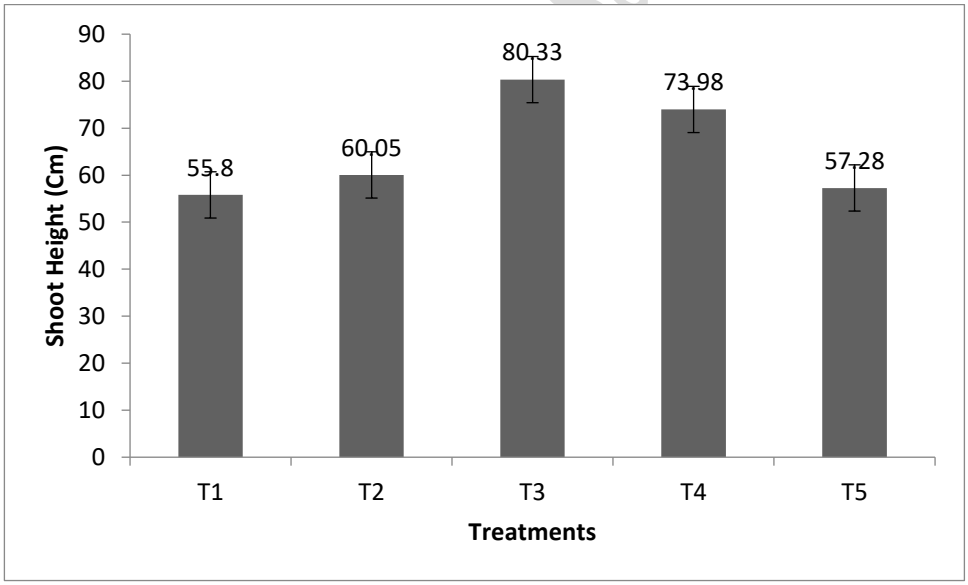

Fig 1: Mean Shoot height of *Vitellaria paradoxa* within 24 months of study

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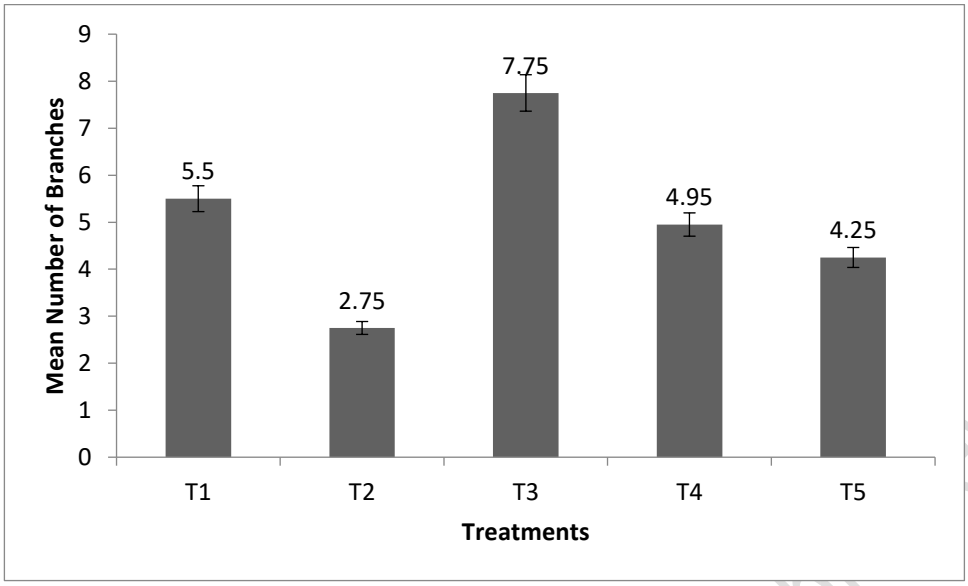

Fig 2: Mean Number of Branches of *Vitellaria paradoxa* within 24 months of study

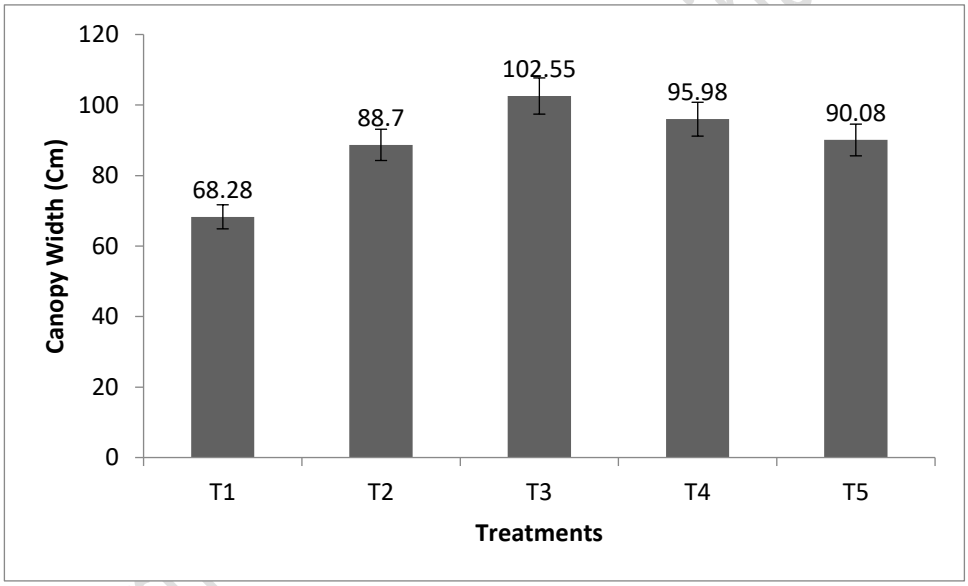

Fig 3: Mean Canopy Width of *Vitellaria paradoxa* within 24 months of study

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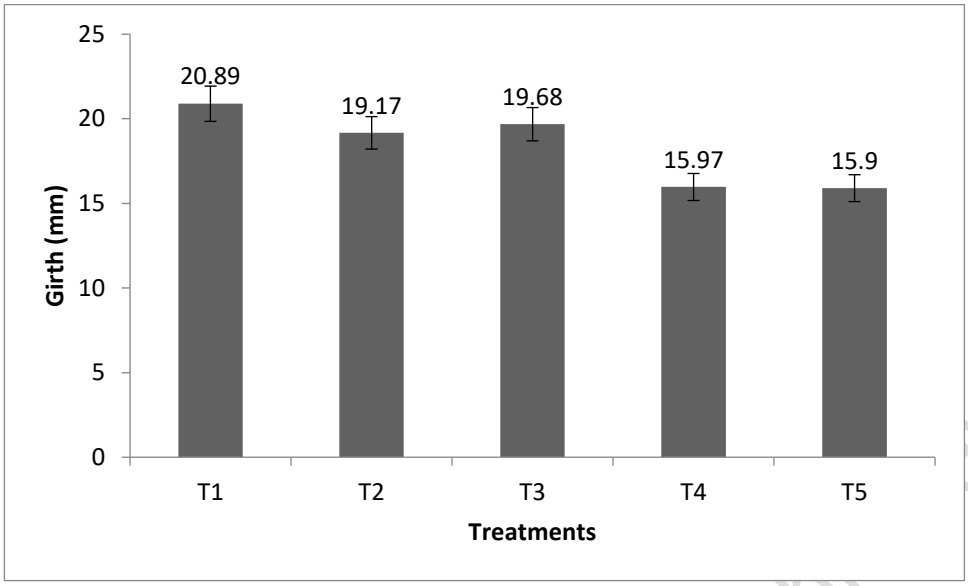

Fig 4: Mean Girth of *Vitellaria paradoxa* within 24 months of study

4. Conclusion

It could be inferred from the study that *V. paradoxa* utilized plethora mechanism to establish itself at various depth the species was subjected to. This potentials enabled the species to acquire sufficient and required amounts of mineral nutrients for proper growth and development. The soil depth profile of 25 cm with highest mean values of growth parameters suggests that the planting depth for the species must be within the range of 20 – 30 cm. Most especially for the vigorous seedlings of *V. paradoxa* that are at least 12 months old. Therefore, for appropriate growth potential of *V. paradoxa* on the field and its stability in the soil, the planting depth must not lower than 20 cm having considered various levels of root flare.

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Sustainable Development Implications of Damming for Hydroelectric Power in Ghana: A Literature Inquiry

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Abstract

Damming for hydroelectric power has become indispensable in many countries. With continuous debates surrounding Hydroelectric Projects (HEPs) in the development discourse, this study engaged the sustainable development concept to examine the social, economic, and environmental implications of such projects in Ghana. The study employed a qualitative approach with data from literature, including peer review articles and grey literature. We found that HEPs in Ghana spur up the country's economic development as it produces energy for industrial and domestic use; enhances tourism potentials; improves certain livelihoods; and opens-up transport activities in areas. However, they leave certain negative footprints on some livelihoods and general environment of the country, in contrast with sustainable development principles. The paper argues that though HEPs undermine environmental integrity and social equity as well as presents some unsustainable economic growth, it is impossible to completely do away with them in the short-run. So, countries must manage the short-term impacts while seeking for long lasting solutions by exploring more sustainable sources of energy. This study contributes to the continuous discussion of the impacts of HEPs by positioning it within the concept of sustainable development.

Keywords: Hydroelectric Projects, Sustainability, Environment, Sustainable Development, Ghana

1.0 Background of the Study

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Hydro-electric projects have generated a fair bite of debates in academic literature. Damming for hydroelectric power; the process of obstructing the flow of water bodies to generate electricity (Scudder, 2012), has become central in many economic development models. Countries with water resources that are economically viable have built dams at certain phases of their development for energy and other purposes, for example irrigation, transportation, etc. (Scudder, 2012; Yang et al, 2008; Asit &Tortajada, 2001; World Commission on Dams [WCD], 2000; Adams, 1985). Though dams are pursued to spur economic development, the consequences of their construction have been up for debate. HEPs are touted for the generation of electricity for economic growth and the creation of employment (See Tedesse, 2015; Galipeau, 2013; WCD, 2000; Adams, 1985). Other scholars (See Wang et al, 2014; Fisher, 1999 etc. for more details), however, argue that dams also lead to social, economic, and environmental consequences, which can be far-reaching and permanent than that of other physical developments (Kupferberg et al, 2012; Zhang et al, 2012). It is therefore understandable that there is continuous debate around the subject matter as it comes with both positive and negative, short and long-term impacts. Thus, it remains indisputable that the impact of dams on development remain contentious, and the debates can be strengthened by examining the issue from different theoretical perspectives. Hence, this paper aims to contribute to the subject by employing experiences from Ghana to examine the sustainable development implications.

In Ghana, three main HEPs have been pursued since independence, and these have attracted attention from academics and other actors across a range of sectors. Though studies have been conducted on these projects (See Anthony et al., 2016; Mettle, 2011; Miescher & Tsikata, 2009; Tsikata, 2006; Gyau-Boakye, 2001; Tamakloe, 1994), there exist no synthesised outlook of the existing literature, more less from the sustainable development point of view. This study, therefore, seeks to contribute to the exiting body of knowledge by discussing the implications of HEPs from the perspective of sustainable development, employing synthesis of existing literature. This study will improve understanding about the balance between the economic development drive that influences HEPs and the consequences on the environment, economic, and socio-cultural fibres of societies. This will be achieved by answering the research question: *what are the social, economic, and environmental implications of HEPs in Ghana?*

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To answer the above question, the study examines how HEPs impact on socio-cultural elements of communities in Ghana; assesses how HEPs affect environmental sustainability in Ghana; and explores the economic implications of HEPs in Ghana. Focusing on the balance between the economic drive and impacts on social and environmental elements of society, the paper improves our understanding in striking a balance between these factors in terms hydro-electric dams in Ghana and beyond. Hence, discussions and findings will potentially serve as an important resource for development managers and policy makers in managing projects of such magnitudes.

2.0 Conceptual Approach

The study is constructed around the concept of sustainable development, which has been defined as the ability of the present generation to make use of resources to meet their needs in ways which do not undermine the ability of future generations to do so (World Commission, 1987). In addition to the standard definition put forward by the Brundtland Commission, sustainable development involves ensuring that economic growth does not undermine social and environmental prosperity (Redcliff, 2005; Lele, 1991). Also, sustainable development involves two main scopes; fair balance between various developmental dimensions and intergenerational justice (Langhelle, 2000). Hence, development actions must not be detrimental to sections of society, nor to future generations. Though there are more complex conceptualizations of sustainable development, this study is conceived around the simple "Three Pillar Basic Model" (Centre for Environment Education, 2007) (See Figure 1).

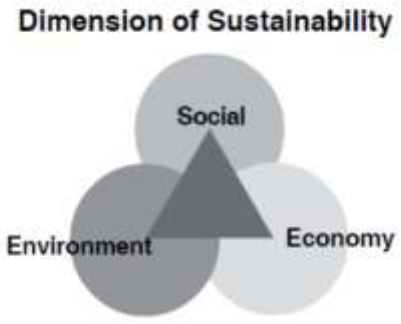

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Figure 1: Three Pillar Model for Sustainable Development

Source: Centre for Environment Education (2007)

This study examines the socio-cultural, environmental, and economic impacts of dams, engaging the sustainable development concept to ascertain whether we must care about HEPs. Proponents of HEPs argue that, dams are consistent with sustainable development because they assist in and spur economic development through the various services they provide (Tedesse, 2015; Galipeau, 2013) while critics of dam creation point to the fact that dams are socially, environmentally, and economically unsustainable (Alhassan, 2009). According to Alhassan (2008), HEPs can be sustainable or otherwise, dependent on how they are used in the process of development. Thus, for HEPs to be sustainable, they must place equal privileges on social and environmental issues as well as economic development (Alhassan, 2008), and this must be done in both present and future terms. HEPs must therefore grant equal weight to and balance the social, economic, and environmental needs of development based on the key principles of sustainable development (Flint, 2004). The study thus examines HEPs, focusing on balance among aspects of development in line with the three principles of economic vitality, environmental integrity and social equity associated with sustainable development (Flint, 2004).

3.0 Methodology

The paper examines the multiple realities associated with HEPs and their accompanying consequences in the context of Ghana. This is based wholly on literature re-creation, a research approach which focuses on making use of existing knowledge in the field of study (Murray and Begler. 2009). A snowball approach was adopted for retrieving articles. We started the search for articles and documents in November 2016 with simple google query for impacts of hydro-electric projects in Ghana. And by virtue of the limited spatial scope, most recent articles on the subject was retrieved. Their references were followed to get more relevant articles that speak to the subject. This was complemented with searching scientific databases mainly from Memorial University of Newfoundland Libraries *One Search*. Various government and agency reports were also sought online to support and to triangulate data from journal-reviewed articles (Creswell & Plano Clark, 2011; Creswell, 2007). Whilst other relevant articles talked about HEP construction and their impacts, only articles that focused on HEPs in Ghana were considered

for this review. However, lessons were drawn and referenced to that effects from other scholarly works that were conducted in different areas. Review for this study entailed locating and summarizing previous studies about how HEPs impact the environment; natural and man-made components. Data was uploaded into NVivo 11 for further analysis. Pre-determined themes based on the three pillars of sustainable development outlined above formed the basis for review and analysis. The themes were read and further analyzed deductively to produce this article.

4.0 Background of Hydroelectric Dam Projects in Ghana

Ghana, just like many other countries in the world, has pursued energy generation using water resources. The country has embarked on three HEPs (See Figure 1) to stimulate economic growth as well as improve general living conditions through efficient energy supply. Ghana's first HEP was known as the Akosombo dam. The actual building of the dam took place within 1961-1966, controlled by the Volta River Authority (VRA) who were legally mandated by the Volta River Development Act, 1961 (Act 46) to be managers of all Volta River related activities in the country (Kalitsi 2000). Being the first, the Akosombo Dam was designed as a single-purpose rock-filled HEP with its power plant made of an initial installed capacity of 768 Megawatts and estimated at a cost of about £230 million (Alhassan, 2008). The main purpose for the construction of the dam was to cater for the energy needs of Ghana's industrialization drive right after independence in 1957. Construction of the dam led to displacement and relocation of about 80,000 people from 739 communities located in various parts of the Volta basin (Mettle, 2011; Zorgbo, 2001).

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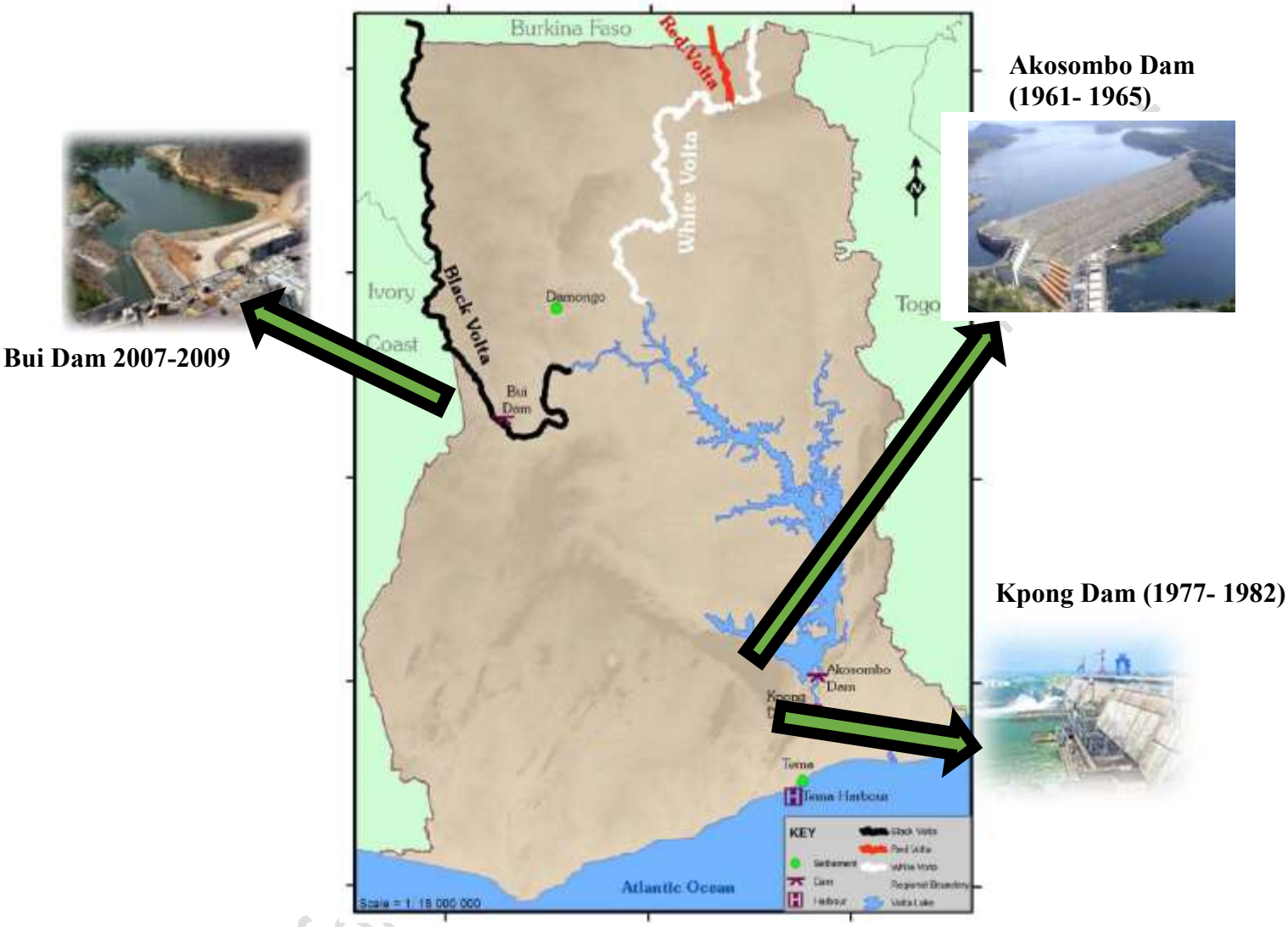

Figure 2 Hydroelectric Dam Projects in Ghana

Source: Adopted from Mettle (2011)

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The second HEP in Ghana was the Kpong Dam, built about 24 kilometers downstream from Akosombo (Girmey, 2006). The project was instituted as an extension to the Akosombo Dam from US$39 million loan from the World Bank between 1977 and 1982 (World Bank, 1993). Kpong project constituted four

generating units of 160 Megawatts capacity and related infrastructures needed for its operation. Generally, the Kpong project resulted in resettlement of about 7000 people, who were forced to leave their original lands to give way for the construction works (Gimmey, 2006). The third HEP in Ghana is the Bui Hydroelectric Dam (BHP), located on the Black Volta River, in the southern end of the Bui National Park. BHP is approximately 150 kilometers (km) upstream of Lake Volta, permanently inundating over 440 km^2 of land, and occupies 21% of the area of the Bui National Park (ERM, 2007). According to ERM (2007), the BHP is expected to generate a net average annual energy of about 1000-Gigawatt hour/year (GWh/yr) for an installed capacity of 400MW (Obour et al., 2016). Constructed in from 2007-2009, Bui dam displaced about 1216 people who were then resettled in two resettlement schemes (Mettle, 2011).

Social Implications of HEPs

One of the key pillars to sustainable development is societal welfare or health, and this can manifest across various aspects of life. Discussions on the social components of sustainable development have centered around a range of issues including, but not limited to culture, religion, social capital and livelihoods which are important in maintaining societal fibre. In Ghana, culture, religion, and in many cases, livelihood activities form important components of society. The resilience of society therefore depends much on how these elements are protected and shaped by development activities. Thus, how HEPs impact these elements of society are important in shaping sustainable development in the country. The literature points to direct impacts on people through displacement from original home, loss of livelihood assets, disruption of livelihood capabilities, breakdown of cultural values and creation of new opportunities like improved housing and education.

HEPs in Ghana have had diverse impacts on sustainable livelihoods of communities (Fynn & Abdulai, 2018). At the forefront of HEPs and sustainable livelihoods is the displacement of communities from livelihood assets including natural and physical foundations of living (Livelihood assets) (Mettle, 2011). People are attached to their environment, and make use of natural assets like land, water, forest, and many others for sustenance. HEPs in Ghana have led to the displacement and resettlement of

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approximately 82,000 people and more than 750 villages in various locations since the 1960s (See Mettle, 2011; Gyau-Boakye, 2001) (See Figure 2 for details). Displacement of such large numbers of people in the country has been an issue of debate for long, considering its long-term impacts on livelihoods. For example, Gyau-Boakye, (2001) opines in the case of the Akosombo dam that, the loss of land due to displacement led to a decline in the activities of crop and livestock farming for both downstream and upstream communities. The loss of naturally fertile soils beneath Lake Volta essentially led to the loss of traditional farming practices. Due to reduction in arable land for farming, people diversified (other activities to meet personal needs) and switched livelihoods for sustainability. The men switched from farming into fishing while some of the young women engaged in prostitution to satisfy the male labourers working on the dam project since it is a taboo for women to fish in some communities in Ghana (Suave et al. 2002).

The issue of displacement and livelihood is also noted by Mettle (2011) who cites similar challenges regarding the Bui Project. The author argue that the resettlement of communities resulted in loss of valuable natural resources (Lands and fishing grounds), leading to change in livelihood options. A study by Atindana et al (2015) confirmed this fact as it revealed that, in Lucene and Agbegikuro, two resettled communities in the Bui Project, more than 30 % of the people changed their livelihood activity from farming to fishing while over 30 % of the people moved into construction of the dam due to sudden changes to livelihood assets. Funn and Abdulai (2018) also corresponded in uimpact of the Bui project on livelihoods of communities resettled in the Phase A. Studies Girmay (2008) and also revealed similar impacts of the Kpong dam on livelihood options of resettled communities. Though livelihood diversification and changes could be viewed as positive inputs towards sustainability, it becomes an issue which undermines the tenant of sustainable development when external forces induce them as in the case of HEPs in Ghana.

Also, HEPs in Ghana have also impacted cultural ties of communities (Gyau-Boakye, 2001), an important livelihood asset of societies (Chambers, 1995). Gyau-Boakye (2001) studied livelihood issues resulting from Akosombo long after the project was completed and found that there were many socio-physiological problems in the communities including breakdown of cultural practices and traditional law and order.

These, he argues, were mainly due to break down of the social fibres that held the original communities prior to their displacement. Atindana et al (2015) also found similar problems in the early stages of the Bui resettlement program. They noted that, religious worships in communities were negatively affected as sacred grounds, animals and structures were lost to the dam. The culture of the people was negatively affected as many previously distinct villages were lumped together into single resettled communities, creating new cultural mixtures which undermined old ones (Obour et al, 2016; Atindana et al., 2015; Mettle, 2011). The issue of breakdown in social connections or linkage due to the out-migration of people from their communities has also been cited by Gyau-Boakye, (2001) in the Akosombo resettlement program where resettled communities lost their socio-cultural values over time.

Another important component of livelihoods, and a pillar to individual and social sustainability is capabilities. Capabilities refer to the inherent abilities of people used to transform assets or resources into a means of living (Chambers, 1995). Studies (for example, Fynn & Abdulai, 2018) on HEPs in Ghana have pointed to diverse impacts on the capabilities of affected communities. For Fynn and Abdulai (2018), capabilities fluidy and difficult to measure, but the Bui project made some rendered certain capacities useless since people did not have access to the assets to support them. Also, issues of health which affects capabilities have been cited in the literature. For example Zakhary (1997) and Sam (1993) all attribute issues of health, especially malaria, to the Akosombo dam. Relatedly, years after completion of the projects, malaria was cited as the commonest disease (about 60 percent of households) among residents of the Bui resettled communities (Atindana et al., 2015) as well as Akosombo and Kpong (56% of households) (Gimmay (2008). The fact that the health of the people in a community is pivotal to sustainable development efforts (Schantz, 2017; Lim, Fullman, Murray, & Mason-Jones, 2016) as evidenced in the United Nations' Sustainable Development Goal 3 which focuses on Good Health and Well-being for all ages by 2030 (United Nations, 2015).

Notwithstanding, studies have also revealed specific positive implications for sustainable development through benefits for displaced communities. There have been mentions of development projects such as better housing, improved road networks, and improved access to electricity and other social amenities and services in resettled communities (Fynn & Abdulai, 2018; Mettle, 2011; Mine, 2014) due to

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relocation into well planned neighbourhoods. However, Fobil et al (2001) debunks this argument, noting that, although the inhabitants of Akosombo Township enjoyed good social services compared to many urban areas, the same cannot be said about other upstream and downstream communities which are among the poorest in the country. Mettle (2011) and Alhassan et al., (2015) also argued from the perspective of the Bui project that, resettled communities still lacked certain basic social services, and the resettlement compensations given out were inadequate to cater for their needs. Similar issues were also mentioned in the Akosombo and Kpong HEPs by various studies about communities' dissatisfaction with resettlement compensation packages (See Otu-Tei, 2014; Tamakloe, 1994).

Related to issues of compensation controversies, weak political drive, and interferences with the processes of environmental assessments have also been cited as key challenges of HEPs in the Ghana. Banning of UK based Daniel Bennett in 2001 from conducting studies in the Bui National Park due to the renewed interest of the then government to construct the Bui dam is a typical example of political interferences and neglect for environmental assessments (WorldTwitch, 2002). HEPs in Ghana generally have negative implications for social development, the activities involved in execution and their abilities to positively impact peoples' lives. Though not all impacts of HEPs on livelihoods are negative as can be seen in parts of the discussion, their consequences on livelihoods of communities undermine sustainable development. This is because they undermine social equity and sustainability considering the impacts on livelihood assets, capabilities, human health, and cultures of communities. This conclusion affirms the works of WCD (2002); Galipeau et al., (2013); Scudder (2012); Kupferberg, et al., (2012); and many others who noted predominantly undesirable impacts of HEPs on livelihoods and sustainability of communities in different parts of the world.

Environmental Implications of HEPs

Environmental sustainability is one of the main pillars of sustainable development. It is often seen as the critical component and the driving force of sustainable development because it is often overlooked in pursuit of economic prosperity. This may explain why environmental sustainability is a key area of concern for opponents of dams. Opponents of HEPs have largely cited negative impacts on the environment, alongside changes to livelihoods as the main arguments why governments must be critical

when developing HEDs (Wang et al, 2014). In Ghana, HEPs projects have had diverse impacts on the environment, including deforestation and loss of fertile lands, growth of water weeds, flooding and its consequences on nature, and loss of wildlife. According to Fobil et al., (2001) Ghana lost about 3.6 percent of its arable land including forest covers to the creation of the reservoir in the Akosombo HEP. The construction caused deforestation as forest cover was extensively cleared to site the project as well as resettle displaced riparian communities (Girmay, 2008). The dam therefore had negative repercussions on the vegetation cover of the country. Construction of the Akosombo dam also led to the growth of various aquatic weeds and tree stubs in the Volta river which impeded transportation on the Volta lake for some time (Abrokwa-Ampadu, 1984). Girmay (2008) also found that the Akosombo and Kpong projects also had serious environmental impacts in the country. For example, downstream riparian communities usually experience flooding when the dams are opened to release water (Girmay, 2008). The resultant persistent flooding of the downstream areas was noted to cause various degrees of erosions and land degradation in communities along the river.

Studies have also showed similar environmental implications of the Bui Project. In constructing the dam, the Bui National Park was significantly affected as about 21% of its reserve was submerged (Ferdinand, 2015). Another dimension of that project has been the threat to a near extinct wildlife as the Bui National park which hosted about 250-350 hippopotamuses was threatened (Ferdinand, 2015). However, there is no current data on the actual impact of the project on the hippopotamuses' population in the park. International Rivers (2016) has however raised concerns on the potential threat of the dam on about 46 species of fishes important to local communities as their natural environment was altered. Ferdinand (2015) further argued that, eventually, Bui dam could also have other serious environmental impacts, such as changing the flow regime of the river, which could harm downstream habitats. HEPs in Ghana have also been noted to have caused major seismic and climatic changes. Gyau-Boakye, (2001) studied the environmental impacts of the Akosombo about 30 years after it was completed and found increment of Reservoir induced seismicity (RIS).

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The study also found that there was increased channel bed scouring which had led to significant reduction in sediment load downstream. Some profound morphological changes were also found along the stretch of the Volta river downstream of Akuse and this happened alongside continues eastward movement of the channel through which the Volta river entered the sea, leading to about 12 km shift since 1974 (Anthony, 2016). Also, about 4 major earthquakes of magnitude 5 or higher have been recorded in the area around the Volta Lake and this has been attributed to overloading of the geological bedrock underlying the lake which is triggering the active Akwapim fault (Gyau-Boakye, 2001). The BHP also led to similar major changes with an increase in seismic activities around the project area since the construction of the dam (Hensengerth, 2013). Transformation of vegetated lands into water bodies the three HEPs also caused significant changes in surface albedo thereby altering the "local heat budget", resulting in climatic changes in the Northern parts of the country, with temperatures rising by more than 2o C since 1974 (Gyau-Boakye, 2001).

The preceding discussions have highlighted impacts of HEP s in Ghana on the environment. The discussions have shown major impacts of HEPs which have obvious negative implications for environmental integrity. Loss of vegetation covers, increase in seismic activities, flooding of downstream areas, increase in water weeds, increase in water related diseases among others have been revealed in the discussions, and all these undermine sustainability and sustainable development in the broader sense. The study therefore confirms the environmental unfriendly nature of HEPs as opined by many authors using experiences from China, Brazil, and other countries (Richter, B. et al., 2010; Wang, et al., 201; Yang, et al., 2008). Discussions in this section therefore raise serious questions regarding sustainable development in areas where these projects are pursued. Independent consideration of environmental impact assessments prior to projects initiation will potentially minimize their long-term impacts. This, however, requires strong political commitment from decision makers who are at the helm of affairs in directing such projects.

Economic Implications of HEPs

One of the most taught drives for HEPs is its expected economic prosperity. Countries that have pursued such projects have usually based their arguments on the economic benefits of such projects. Same can be

said of most supporters of dams, who have usually cited the economic benefits of HEPs as reasons why countries must be allowed to pursue them (Fonseca, 2003). To understand the implications of HEPs on sustainable development in Ghana, the section discusses its impacts on economic development in the country, both micro and macro-levels of society, where displaced communities are considered. Even though environmental and social impacts of HEPs as discussed in the preceding sections have been largely negative, these projects also present some economic benefits in Ghana. HEPs in Ghana come with various economic benefits and opportunities to the country as well as displaced people. Some commonly cited benefits include electricity for business development, creation of employment opportunities, fostering of tourism, and lower/community level new economic opportunities.

From a broader perspective, more than two-thirds of all the electricity produced by the HEPs goes to industries and commercial entities, leading to rapid expansion of the economy (Alhassan, 2008). The construction of the trio power projects brought many industries into Ghana from other West African countries to take advantage of the cheap electricity, though growing pressure on existing systems have strained electricity supply in the last decade. IMF (2010) notes that, following the construction of the first power project (Akosombo HEP) in Ghana, the country's economy grew by twice the average of the economy of the whole West Africa sub-region. The world money regulator further indicates that periods of poor HEP energy generation due to droughts, unemployment rates in the country keeps rising, thus attesting to a positive externality of HEP on employment opportunities. This is particularly true as the current energy crisis in the country, lasting for almost a decade due to decline in hydroelectric power generation has led to the collapse of more than 1,000 small scale industries (Peterson, 2015).

HEPs therefore create numerous employment opportunities directly and indirectly through spurring economic activities that come along with the availability of cheap supply of hydroelectric power or energy. Also, all three HEPs have produced enormous potentials for water transport in the country. Navigation of the Volta River has changed tremendously since the construction of the Akosombo dam and subsequently the Kpong and Bui dams along its course. The three dams have played diverse roles in serving as means of transport for humans and goods, opening previously inaccessible locations (UK Essays, 2015). Gyau-Boakye, (2001) in affirming this argument used the Akosombo experience, stating

that the project opened a transportation route which provided an important link between the northern and southern parts of the country, yielding enormous economic benefits to communities and the country at large.

HEPs have also been noted for other benefits and opportunities including promotion of tourism in the country. Kalitsi (2010) in explaining this argues that, creation of such dams opens inaccessible communities with tourist attractions to many tourists. Citing the Akosombo experience, Kalitsi (2010) argues that the location of the dam, the sight of the lake, and the serene environment attracts both local and international tourist which was because of building HEP. (Kalitsi 2010). Same can be mentioned of the Bui dam as its construction brought the Bui National part into the limelight, propelling many tourists to visit the place to have a feel of both the dam and nature around it (Ferdinand, 2014). Though discussions about economic implications of dams have usually focused on the broader spheres, there are lower level impacts that could be highlighted. Discussions under social implications highlighted some of these lower level economic impacts. Studies have pointed to complete change in economic activities in displaced communities, to diversification of activities/careers to cope with strains on natural resources by HEPs (See UK Essays, 2015; Otu-Tei, 2014; Gyau-Boakye, 2001; Tamakloe, 1994 etc.).

HEPs have had both positive and negative economic implications for displaced communities and other communities around projects sites. Some of the positive impacts of HEPs include the introduction of new economic activities, like resident's involvement in construction works (Atindana, 2015; Mettle, 2011), fishing and trading activities (Atinadana, 2015; Kalitsi, 2010). Instances where people lose their sources of livelihood and economic sustenance as explained under social implications also raises questions of economic implications of HEPs at the local level. Economic implications of HEPs, as revealed in literature varies in different way/levels. From the broader spheres, economic impacts are largely positive, however, same cannot be said at the local level. There have been mixed results at the local level, with such projects providing new economic avenues while also displacing residents of affected communities. In this sense, HEPs could facilitate or undermine economic sustainability depending on the scale and context. Wholesale conclusions on economic contribution of such projects to sustainable development must therefore be carefully made in any context.

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5.0 Conclusion and Way Forward

This study examined the impacts of HEPs in the context of Ghana, positioned in the context of sustainable development. The contrasting impacts of HEPs as discussed in this study calls into question the position of such developments in sustainable development. Though HEPs have brought about economic growth and improvement in some aspects of livelihoods, their immediate and long-term negative impacts threaten environmental integrity and social equity. The case of Ghana has also shown unsustainability in terms of future capacity of the much-acclaimed economic vitality of HEPs. Discussions point to the benefits and challenges of HEPs in Ghana. Though the benefits are obvious, there remain questions on distribution and sustainability. Though electricity is generated to support economic growth, enhance transportation, improvements in certain forms of livelihoods like fishing and creation of general employment, the benefits are not encouraging as people of displaced communities usually have limited ability to take advantage of such opportunities, hence, undermining social sustainability. This confirms the assertion by some opponents of dams that the economic vitality of such projects is not always sustainable (Wang et al, 2014; Biswas, 2012). Amid such uncertainty and ambiguity on the vitality of HEPs, the position of HEPs in development discourse remains controversial (Alhassan, 2008; Flint, 2004). The study concludes that HEPs threaten sustainable development and have consequences on sustainable development that policy and decision makers must consider before embarking on such projects.

Despite threats to sustainable development, it is impossible to undermine the economic growth HEPs stimulate as well as the difficulty in completely doing away with power projects considering the limited and high cost of available alternatives. Countries will therefore continue to pursue HEPs as they drive for economic growth. The important issue then, is to focus on managing the weaknesses and consequences that come with HEPs in the short run. If sustainable development is to be achieved, the role of energy for domestic and industrial purposes cannot be discounted. However, more sustainable ways must be explored in this regard. Effective planning and implementation of hydroelectric projects using participatory approaches (Richter, et al., 2010) could help minimize their long-term negative impacts on livelihoods of affected communities. Ensuring proper assessment of environmental impacts

and show of strong political will to protect human life and nature could also help minimize the environmental implications of such projects. The use of more environmental-friendly energy sources must also be pursued in future if sustainable development is to be achieved.

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Governing Forest through Standardization and Certification: Understanding the Politics of Neoliberal Governance of Forestry Stewardship Council

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Abstract

In recent decades, governments around the world have been experimenting with neoliberal approach in forest resource management through environmental standardization and certification in an endeavour to lessen financial and operational constraints and tensions between multi-stakeholders. Neoliberal era invites distributive politics that show a growing transfer of authority from public realm to private agents, civil society, whether non-profit or corporate-a clear sign of diminution of that power. Under these circumstances, a new managerial system develops for forest resource management in global context, which is Forestry Stewardship Council (FSC), the first independent non-profit global standardization and certification network. Though limited by secondary analysis, this paper does not focus on the strengths or the weaknesses of FSC but to argue this new governance under two different theoretical perspectives of Foucauldian governmentality and neo-Gramscian hegemony in identifying whether this new forms of governance bring a better management for agencies by restructuring the existing power-politics nexus or to reproduce and ensure the interest of previous one.

Keywords: Neoliberalism, FSC, Governmentality, Hegemony

1.0 Introduction

Neoliberal era invites distributive politics that show a growing transfer of authority from public realm to private agents, civil society, whether non-profit or corporate—a clear sign of diminution of that power. Under these circumstances, a new managerial system develops that overarches and regulates forestry sector by setting different standards and certifications (Lipschutz and Rowe, 2005). In this context of neoliberalism, the world already has witnessed a proliferation of standards in global governance by the

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last two decades which is based on the principle of 'acceptance of shared rule by a community as appropriate and justified' (Ponte et. al. 2011). This is the third wave of voluntary private standards which combines the first wave (social movement based) and the second wave (business to business) where producers, retailers, Banks, crushers, exporters, NGOs, industries, etc., all come together (Multi Stakeholders Initiatives or MSI) to play a role in global environmental governance.

Forestry Stewardship Council (FSC) is the first independent non-profit global standardization and certification network. In 1993, Forestry Stewardship Council (best known non-profit certification group) lunched in Washington as an 'activist regulation body' comprises different organizations and associations from twenty five countries, initially funded by World Wide Fund for Nature (WWF). FSC structures with equally weighted three chambers. These chambers include: environmental, social and economic and the chambers that also equally weighted between the North and the South. FSC is often painted in the literature as one of the most ambitious and successful transnational non-governmental regulatory schemes in the world because of its 'democratic' structure of governance (Moog, Spicer and Bohm, 2014).

Structure of FSC Governing Body

Decision Making Bodies	Chambers	Balance of Power
General Assembly Of FSC Members	Environmental	North South
Board of Directors	Social	North South
Director General	Economic	North South

(Source: FSC, 2011)

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As Klinke (2014) tells, FSC appears as a policy solution that meets-up the challenges and problems of scientific vagueness but not grows as epistemic institution and not much successful with protection. European Union and World Bank join to finance FSC but many studies show that FSC is currently very fragile due to its commitment in stopping forest degradation and maintaining equal standards for all. Even some activists and academicians tell that FSC is appeared with nothing new but a continuation of previous 'governance' (Lipschutz and Rowe, 2005; Moog, Spicer and Bohm, 2014; Taylor, 2011; Bloomfield, 2012). This essay does not focus on the strengths or the weaknesses of FSC but to approach the style of governance through the lenses of two different theoretical approaches where one aims to highlight the rationalities and technologies of this new governance processes that bring global stability over forestry sector and the other focuses on whether this new compromised governing condition brings a new equitable form of operation or just a continuation of older one with new arms. In so doing, Foucault's concept of governmentality is adopted with its focus on rationalities and governmental technologies that explain the new governance while neo-Gramscian hegemony is also adopted to expose counter rationalities and counter technologies that embedded with FSC initiatives (Burchell et al., 1991; Dean, 2010, Levy and Scully, 2007). However, the conclusion part indicates the essay's position towards the nature of this neo governance whether it is a neo form of governance or not.

Approaching Governmentality and Hegemony in Approaching FSC

In the discussion of political economy of global environmental governance, Newell (2008) shows Gramscian 'hegemony' and Foucauldian 'regimes of truth'/power-knowledge as useful to address the current nature of global environmental governance that influences in adopting governmentality and hegemony to explain FSC as a global environmental governing institution. The word governmentality, developed by Michel Foucault, refers to three dimensional characteristics: the rationalities of state [action], the technologies of [exercising] power, and the process of subjectification (Foucault, 1979, cited in Bose et. al., 2012:665). Governmentality is an analytical tool which explains the ways of governance is materialized through consensus rather than violence; the technology of governing people, motivating people, and directing people to rationalize the action of government can be identified as the main features of governmentality (Bose et. al., 2012; Lovbrand and Stripple, 2014). The current green twist to

governmentality is manifested through a notion of stewardship of nature and an all-encompassing management of its resources. Stewardship's rationalities enable the entities concerned to grasp the sphere in need of governing, while regimes of practice, based on their rationalities employ certain technologies to render them practicable (Miller & Rose 2008). In this essay, the background of FSC is explained as rationalities of new governance where consensus formation, standards and certification are analyzed as technologies of this new governmentality.

In order to grasp the other side of the nature of this new FSC governance, many scholar use Gramsci's hegemony theory. Originally, Gramsci (Italian neo Marxist) coined hegemony to explain the reasons behind socialism's failure to persistent Soviet Union and subsequently the return of Capitalism. He explained that capitalism returned due to the failure of socialism in breaking the hegemony of capitalism; hegemony which is lived and carried by civil society, intellectuals, institutions, and educational systems (Gramsci, 1971). Hegemony works by consent and not by coercion (domination with consent). Many scholars (like Cox) apply Gramsci's concepts to international relations and conclude that international organizations can be seen as mechanisms of hegemony as they help to develop and stabilize the dominant order (Cox, 1983, Newell, 2008, Levy and Scully, 2007). In this essay, Gramscian perspective also used in explaining the underlying nature of FSC Governance so that it may help in depicting a broader perspective for mitigating the current challenges while delivering future directions of global environmental governance.

Governing Rationalities in FSC

Since 1984, Friends of the Earth begin campaign for boycotting tropical timber products, including not only wood products but also food products from land cleared of its forest cover (Mulligan and Hill, 2001 cited in Taylor, 2011). This contributed to bring wood and paper under high scrutiny in terms of their environmental impacts. Protests become an integral part of annual meetings of Western leaders and corporate executives in recent years. Anti-globalization movement is now perceive as global justice movement that covers human rights violation to environmental destruction, working condition issues globally. On that circumstances, when the conference of 1992 ended without any agreement, that

triggered new global non-state initiatives for forest governance. Bargaining on 'global forest agreement' (regulation viz compensation) between industrial countries (IC) and developing countries (DC) when failed during 90s, create the momentum to public regulation on forestry as a dead theorem (Fogel, 2002 cited in Lipschutz and Rowe, 2005) and simultaneously, NGOs and activists started to build a new kind of private regulation where company, community, civil society and third party certification work together within the management. These circumstances provided one of the main rationalities for the formation of the Forest Stewardship Council (FSC) and its respective certification scheme as a means of verifying that forests were being managed to an acceptable standard as new global governance over forestry sector (Cashore et. al. 2004).

According to Gramscian explanation, the volatile bourgeois forest economy needed to develop a strong hegemonic reproduction system where political-economic constraints, and the interplay of corporate and social and cultural actors which produce existing hegemony by corporate-civic collaboration within market mechanism. FSC appeared as a new machine of bourgeois hegemony production. Politics of situational improvement is merely a tactic to maintain the dominance of particular classes. FSC, the compromised settlement that asserts control by the global North over the South by including the stakeholders in one table or cocked starta, is a potent way to deal with the aharmonic situation of governance that suited with the neo-liberal environment (Li, 2007; Bartley, 2007). In neoliberal era, politics through market is an acceptable practice because what state does now, global civil society does the same by forming a coalition with state, capital, and market which help more effectively to harmonize and stabilize the condition that are seen as disturbance to the welfare for human population (Newell, 2008; Dean, 1992). FSC is a kind of organization which is framed over these kinds of global political rationalities and appears as a trouble-shooting mechanism which contain the hegemony of dominant class or a market mechanism through managerialism.

Nature of Technologies of government in FSC

In Foucauldian perspectives, rationalities provide the field to produce the technologies of government. Consensus is a governmental apparatus which aims at striking a vision, a way of presenting facts and a

direction of their interpretation (Ranciere, 2005 cited in Dajma, Fouitteux and Vagneron, 2011). FSC provides different types of forums to members and stakeholders through different level of discussion, which accelerate consensus on diverse issues. The principal forum is the General Assembly that meets every three years but is frequently asked to decide on various issues by mail or email. The nature of decision making process is almost based on consensus not in ballot or compromised (Dajmaet.al. 2011). The positionalities in FSC provide the scope for sales talk, which is an important aspect of environmental governance through forest certification that escalates the consensus environment between the stakeholders (Albrecht, 2013).The FSC develops auditing standards that are designed to ensure that the world's forests are well managed, and accredit auditors who certify the quality of forest management (FSC, 1994; WWF, 1994). The certification builds a type of managerial expertise. Audit also reinforces managerialism within standard setting. On the one hand, consensus provides the internal legitimacy while the audit provides the external legitimacy on the other. The FSC planned to achieve these goals by establishing auditing standards and by evaluating and accrediting forest management auditors worldwide on the basis of ten primary principles. In this way, behavior of stakeholders is controlled from the distance (Rydin 2007; Higgins and Larner 2010).

Gramscian scholars (Newell 2008) are agreed that FSC is quite innovative in its apparatus and technologies of government but the intention of these mechanisms is not to break the existing structure rather to reinforce the dominant hegemony. Forest degradation is continuing without any significant development in forest management is appeared while monoculture or industrial plantation is encouraged by FSC and also it closes the door of community-based forest management (Lohmann, 2003). The Quebec case demonstrates a serious violation of FSC basic principle and present a reverse site of consensus where FSC certified company deployed enforcement agency to extract forest resource in facing aboriginal resistance (Russ, 2012). The most conflicting nature is seen in FSC, when certified bodies are paid or sponsored by the companies those are in the queue to be certified; only large businesses with rigid structures even can afford the process of assessment and maintenance on this schemes. Moreover, FSC works within the neoliberal trade rules and its principles (followed WTO regulations) give same treatment to any company whether it is domestic or international. FSC becomes a new empire in market regulation.

According to the 'Facts and Figure, 2016, FSC currently operating 186,410,374 ha forest land (FSC, 2016) over 80 countries with 860 stakeholders, and some 40,000 certified companies (FSC, 2009). These explanations indicate that the business as growth hegemony is embedded in underlying charter of FSC rather creating counter hegemony of environmental governance. Moreover, many founding stakeholders like FERN, FOE-UK, and the Rainforest Rescue leave the platform by blaming FSC as a body, which works as a capital accumulation machine rather than responsible forest management. In such, hegemonic nature of FSC becomes clearer day by day.

Conclusion

This essay presents a critical view of the responsible forest management under FSC. It also explores that it is a kind of distributive politics rather than constitutive politics that deals with how points are scored about the what, when, where and who are the partner of new governance which maintain and reproduce the existing hegemony of forest governance. In fact, FSC has very limited ability to change the governmentality of business as growth structure due to its embeddedness with market civilization. Moreover, FSC is one of the disciplinary bodies that work in the forestry sector by creating a stark of utopia to depoliticize and reduce the tension between industrial countries and developing countries regarding forestry regulation. It is appeared that Gramscian explanation has an edge over Foucauldian interpretation in approaching the underlying charter of global environmental governance especially in the case of FSC. However, these approaches are less applicable to estimate about the outcomes of governance processes by explaining the actual sustainability or suitability of the employed rationalities and technologies but it provides broader understanding to disclose how governance processes are produced in a relational and rational space which may able to show the development alternatives.

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