Economic Growth, Globalization, and Governance as Determinants of Environmental Quality in Sub-Saharan Africa

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Abstract

Even though Sub-Saharan Africa (SSA) is experiencing unsustainable environmental degradation just like the rest of the world, most environmental health studies have focused mainly on the Organization for Economic Co-operation and Development (OECD) countries and other emerging markets. Unimpeded environmental degradation portends many environmental problems with enormous economic and social costs. Therefore, the purpose of this study is to explore the impact of socio-economic, global, and governance factors on environmental sustainability in SSA. Understanding the interaction of these factors will be of immense assistance to policymakers and other officials charged with mitigating environmental degradation in SSA**.**

Utilizing data from 42 countries in SSA covering 1970 - 2018, our empirical estimations using the Generalized Method of Moments (GMM) technique revealed that the primary determinant of environmental performance in SSA is the level of economic activities. The results show a statistically significant positive relationship between economic activities (GDP) and environmental performance. This result does not support the existence of the Environmental Kuznets Curve (EKC) in SSA. Surprisingly, the level of public debt had a statistically significant positive impact on environmental performance. The governance variables signifying the impact of government showed mixed results as political stability, control of corruption, and regulatory quality were not statistically significant, whereas the rule of law, government effectiveness, and institutional strength showed a statistically significant positive impact on environmental performance. Trade openness and population density did not have any statistically significant impact on environmental performance. Mitigating environmental degradation in SSA requires policies that promote income growth and debt forgiveness**.**

Keywords: Environmental quality, sustainability, governance, international trade, globalization, Sub-Saharan Africa

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Introduction

The world continues to grapple with mitigating the negative externalities emanating from the production and consumption of goods and services. High-profile environmental disasters such as the Exxon Valdez oil spill on March 4, 1989, in Prince William Sound, Alaska, and the BP Deepwater Horizon explosion that spilled four million barrels of oil in the Gulf of Mexico on April 20, 2010, are no longer isolated events. In addition to these oil spills, the unprecedented deforestation of the Amazon basin and other tropical forests, and the emissions of harmful gases from manufacturing activities have heightened the awareness that human activities contribute to the worsening environmental problems. While these negative externalities continue unabated, the recognition that human activities constitute a significant culprit in the depletion of the environment is gaining ground. It is now generally accepted that human activities exacerbate environmental concerns such as global warming and ozone depletion, rising sea levels and melting of the polar ice caps, air and water pollution, deforestation, and soil and wind erosion (Chu & Karr, 2017; Guerra-Martinez, 2019; Henn, 2021). Surveys carried out by Dunlap and Scarce (1991) on several environmental issues indicate that majorities accept that the damage to our environment is quite severe. These surveys further indicate that not only are majorities in the USA and Europe willing to pay for environmental protection, but they are also willing to support government intervention in environmental matters (Aidt, 2005; Chen et al., 2022; Dunlap & Scarce, 1991; Eurostat; Sturgess, 2019). Hence, there have been concerted attempts by the international community to address these issues.

Past attempts such as the Paris Agreement[1], Kyoto Protocol of 1997[2], and the 1992 Rio Summit[3] have been used to call attention and proffer solutions to the earth's rapidly deteriorating environment. To mitigate the consequences of environmental degradation, the international community has developed programs such as Sustainable Development Goals (SDG)[4], and Millennium Development Goals (MDG)[5]. Notably, efforts at mitigating the negative externalities of globalization have yielded mixed results mainly because of the difficulty in internalizing the social costs of *environmental* degradation.

The awareness and support for the mitigation of environmental problems are borne out of the realization that the destruction or degradation of the environment portends many environmental problems with enormous economic and social costs. Several studies have stated that environmental degradation/destruction will exacerbate global challenges such as habitat loss, especially for species that have not been screened for their economic value. Other global challenges such as soil fertility and food production, global warming, global and national security, political legitimacy and stability, population growth and economic development have also been highlighted in these studies (Chen et al., 2022**;** Fiorino, 2010; Henn, 2021**;** Mahar, 1989; World Resources Institute (WRI), 1992). Global warming has ominous implications as there is a correlation between the rise in global temperatures and the transmission of diseases that are most sensitive to climate. From the assessment of climatologists, global temperatures would rise by 2.0^{o}C by the year 2100. As Patz et al. (1996) stated, one primary concern of the rise in temperatures is that it would facilitate the transmission of diseases that are most sensitive to climate "…by shifting the vector's geographic range and increasing reproductive and biting rates and by shortening the pathogen incubation period." These diseases would include mosquito-borne diseases: malaria, dengue, and viral encephalitis.

Most existing studies on environmental degradation for instance, Wang et al. (2016), and Bello et al. (2018) have focused mainly on developed countries of the Organization for Economic

Cooperation and Development (OECD) and other newly-industrialized markets. Fiorino (2010) concurred with the above statement when he stated that "available research does focus on economically developed, democratic regimes, so lessons drawn here are limited to that subset of countries." These studies have used data from a mixture of developed and developing countries in a few cases. However, one glaring deficiency in these studies is the neglect of Sub-Saharan Africa (SSA), not minding that some of the world's fastest-growing economies are in SSA. In addition, the most severe land degradation in the world is occurring in SSA. Land degradation in SSA accounts for the largest share (22%) of the annual total cost of global land degradation, amounting to $300 billion (Nkonya et al., 2015).

Furthermore, SSA has the potential to be the breadbasket of the world as about "90% of the remaining 1.8 billion ha of global arable land are located in sub-Saharan Africa and Latin America" (Nkonya et al., 2015). Moreover, SSA is the depository of many of the world's critical natural resources needed by industries in the developed world. Sonnenfeld and Moi (2006) stated that SSA and other developing regions had been neglected in most existing studies due to data paucity. With fledgling democracies, political instability, rampant corruption, weak and non-existent institutions, and extreme poverty, it is imperative that the factors leading to the degradation of the environment in SSA be explored.

Therefore, this study aims to explore the socio-economic, global, and governance factors leading to environmental degradation in SSA. A few studies, such as Cole (2007) and Dasgupta et al. (2001), have lumped developing countries with OECD countries like Germany and Switzerland. Lumping SSA with developed countries may mask the peculiarities of SSA as OECD countries and SSA are clearly on different levels of economic, social, and political development. Furthermore, despite the lackluster efforts at industrialization, the few studies such as Ibrahim and Law (2016), Mehdi (2016), and Sulaiman and Abdul-Ramin (2018**)** that have explored environmental pollution in SSA concentrated on the emission of greenhouse gases (GHGs) such as carbon dioxide (CO_2) and carbon monoxide (CO). In contrast, SSA is experiencing unprecedented environmental degradation resulting from emissions of GHGs and such sources as tropical deforestation and its accompanying challenges such as desertification, soil and wind erosion, loss of habitat, and extinction of the remaining rare species. Hence, in addition to exploring the impact of CO_2 and CO emissions on environmental quality, we must delve into the impact of tropical deforestation, taking place at an alarming rate in every village, town, and country across SSA. This particular dimension, which has been ignored in earlier studies, is incorporated in our analysis.

Furthermore, unlike previous studies that focused on CO_2 emissions as the sole measure of environmental pollution, this study utilizes a more comprehensive measure of environmental sustainability - *Environmental Protection Index* (EPI). The EPI, described in more detail in section IV, is a data-driven summary of the state of sustainability worldwide, comprising seventy-four environmental and non-environmental variables. Unlike CO_2 emissions that focus on one source of environmental pollution, the EPI is multi-dimensional. The use of EPI is noteworthy because, unlike the developed and industrialized countries, where the source of environmental pollution may be primarily CO_2 emissions, the primary source of environmental degradation in SSA is tropical deforestation. Hence, a more comprehensive measure like the EPI is undoubtedly more appropriate in the case of SSA as it incorporates the multi-dimensional aspect of environmental degradation in the region.

By and large, the main drivers of environmental degradation are found, among other things, in the level of economic growth, globalization, socio-economic factors, and governance indicators. Each of these drivers is explored briefly below.

The quest for rapid economic growth is one major cause of environmental degradation. As countries endeavor to lift their people out of poverty, industries are established to create jobs and increase productivity. This increase in productivity comes with negative externalities such as environmental degradation. Practically every study on environmental pollution has identified income growth as a significant source of environmental pollution. This income growth is measured as GDP per capita. In this spirit, the current study enlists GDP per capita as a variable in our empirical analysis.

Globalization is another driver of environmental degradation which comes into play as countries attempt to gain an advantage in international trade. Countries enlist both tariff and non-tariff barriers to managing imports and exports in this process. Developing countries desirous of increasing exports, rather than importing finished products from other countries, would welcome manufacturing plants even if such plants are heavy polluters. This attempt to manage imports and exports is reflected in the degree of trade openness. Following previous studies, we enlist trade openness as a determinant of environmental performance in our model.

One of the socio-economic pressures exacerbating the depletion of tropical forests is the declining terms of trade often experienced by SSA in international markets. As the price of primary products, which constitute the bulk of exports of SSA, continue to decline and export revenues plummet, SSA takes on loans to finance budget deficits. The pressure to service these huge loans often leads to myopic policies that are detrimental to tropical forest conservation interests. To increase export in the face of declining prices, SSA clears more forests to cultivate cash crops and to harvest timber for export. This, in turn, exacerbates tropical deforestation, which leads to environmental degradation. In effect, debt may constitute a drag on economic growth and environmental performance. Surprisingly, except Kahn and McDonald (1995), no other study, as far as we know, has explicitly considered the impact of debt on environmental degradation. Hence, this study explicitly incorporates debt as a variable in our empirical model.

Following earlier studies, this study acknowledges that demographic factors such as population growth and population density may influence environmental performance. This study, therefore, enlists population density as a variable in our regression analysis.

Governance plays a significant role in the environmental performance of any country. As we elaborate in the literature review section, national governments are still arguably the most potent constituency in the quest for environmental policy success. By their control of national institutions, power of the purse, and problem-solving capabilities, the government of any nation heavily influences environmental outcomes. Nkonya et al. (2015) underscore the preeminent role of governance in environmental performance when they state that improved governance is indispensable in getting land users to adopt sustainable land management practices. Hence, governance variables such as the rule of law, political stability, government effectiveness, regulatory quality, and level of corruption are incorporated in our empirical model.

In summary, this study, therefore, improves on previous studies, including those focusing exclusively on SSA, by (1) incorporating the public debt servicing pressure that is inducing myopic policies that are exacerbating the depletion of tropical forest resources and (2) employing a multi-dimensional measure of environmental degradation, the EPI, as one of our dependent variables. Furthermore, this study adds to the scant literature on environmental degradation in SSA.

The remainder of the paper is organized as follows. Section two discusses the literature review, while section three discusses the conceptual framework. Section four takes on data and methodology. We present our empirical results and discussion in section five, while section six concludes the paper.

Literature Review

The main culprit for environmental degradation is the global demand for goods and services. Fueled by the rising incomes of the developed countries and the newly industrializing countries, this increased demand for goods and services will continue, and so will the environmental degradation associated with the production of goods and services. Hence, most of the studies examining the factors that lead to environmental degradation have incorporated the impact of economic growth (as measured by per capita GDP) on environmental degradation.

In an in-depth review of the existing literature on national environmental performance, Fiorino (2010) stated that national governments are still arguably the most potent constituency even though local, regional, and global institutions are engaged in varying degrees in the quest for environmental policy success. This is because national governments, by the control of national institutions, power of the purse, and problem-solving capacities, have a great deal of influence on what happens at the local and global levels. The study examined the extant literature on environmental performance in four broad categories: "growth and income; regime type, in terms of the level of democracy; institutional characteristics of regime type; and institutional capacity." (Fiorino, 2010, p. 2). The study arrived at the following conclusions: (1) economic development and democratic governance are generally positively correlated with environmental policy success, and (2) the impact of institutional characteristics of democracies remains ambiguous or inconclusive.

Employing cross-country data of thirty-one developed and developing countries, Dasgupta et al. (2001) examined the impact of income and institutions on environmental indicators that they developed using quantified analysis of reports prepared for the United Nations Conference on Environment and Development (UNCED) by the countries in their sample. Their empirical analysis reveals a significant positive relationship between income and environmental policy performance, especially when national incomes are adjusted for purchasing power parity. Additionally, they found that as income increases, more areas of the environment come under protection. The study equally highlighted the contribution of institutional development to environmental policy performance. Other studies such as Lin et al. (2017) and Rahman (2020) support the finding that income growth improves the environmental performance in India and upper-middle-income countries, respectively.

Surprisingly, the Environmental Kuznets Curve (EKC) hypothesis, which postulates an inverted U-shaped relationship between pollution and economic growth, is falling short in some of these studies. Stern (2004) attributes this outcome to the fact that developing countries address environmental issues with modern technology as they industrialize rather than waiting later to address these issues as developed countries did. Hence, the EKC hypothesis, which, according to Stern, has "a very flimsy statistical foundation," has been discredited or under scrutiny in these countries.

The EKC is a hypothesized relationship between damages to the environment and economic growth. EKC theory stipulates that damages to the environment increase at the early stages of economic growth and this trend reverses as economic growth reaches a certain level, that

is, an inverted U-shaped relationship. Empirical studies conducted on the EKC have shown differing results. For instance, He and Richard (2009) found little evidence supporting the EKC in Canada using CO_2 emission as damage to the environment. Fang et al. (2020) conducted research on trade openness and the EKC in China and their results support the existence of EKC in the Chinese economy. Gergel et al. (2004) tested the existence of EKC using long-term watershed inputs and the results showed that wealth, a result of economic growth, did not account for much of the environmental changes. In other words, economic growth is not a recipe to solve all environmental ailments.

However, several studies conclude that economic growth initially worsens environmental performance until a certain threshold in per capita GDP is attained. After that, income growth begins to improve environmental performance. In other words, these studies confirm the existence of the EKC hypothesis. Aiyetan and Olomola (2017), examining the impact of economic growth and other variables on CO_2 emissions in Nigeria during 1980-2012, concluded (albeit weakly) that economic growth ultimately reduces CO_2 emissions. The study confirmed the existence of the EKC in the long run in Nigeria. Examining the impact of economic growth and other variables on CO_2 emissions in selected African countries for the period 2005-2019, Mosikari and Eita (2020) confirmed the existence of the EKC in Africa**.** Other studies, such as Sarkodie (2018), Acheampong et al. (2019), and Avom et al. (2020) confirmed the existence of the EKC in SSA. In the same vein, Bello et al. (2018) confirmed the existence of the EKC in Malaysia, while Coskuner et al. (2020) found evidence of the EKC in the Organization of Petroleum Exporting Countries (OPEC). Ren et al. (2014) found evidence of the EKC in China, while Grossman and Krueger (1994) confirmed the existence of the EKC in a cross-section of countries. On the other hand, Egbetokun and Ogundipe (2016) concluded that the EKC manifests in African countries with good to fair institutions while those with poor institutions do not experience the turning threshold for the EKC.

Countering the studies that concluded that economic growth positively impacts the environment, several studies using CO_2 as a measure of environmental degradation concluded otherwise. For instance, Hashmi and Alam (2019), utilizing the STIRPAT (stochastic impacts by regression on population, affluence, and technology) model in a study of OECD countries from 1999-2014, concluded that economic growth is detrimental to the environment as it leads to more CO_2 emissions. Similarly, Sulaiman and Abdul-Rahim (2018)**,** using an autoregressive distributed lag model and covering the period 1971-2010, examined the impact of economic growth on CO_2 emissions in Nigeria. They concluded, as does Sharma (2011)**,** that economic growth leads to more CO_2 emissions. In the same vein, Dimnwobi et al. (2021), utilizing a more multi-dimensional measure of environmental pollution – ecological footprint – concluded, as does Wang and Dong (2019), that economic growth leads to environmental pollution in Africa. Other studies that found that economic growth is detrimental to the environment included Abdelfattah et al. (2018) in the Arab region; Zhou and Liu (2016) in China; Pham et al. (2020) in European countries and Mehdi (2016) in SSA.

There is an apparent dichotomy – positive or negative impact - in the findings of the studies that investigated the impact of economic growth on environmental degradation. However, using the STIRPAT empirical model and the fully modified ordinary least squares while disaggregating economic growth into agricultural and industrial, Lin et al. (2016) concluded that economic development has no significant impact on CO_2 emissions in Africa. They also found no evidence of the existence of the EKC in Africa.

Trade openness is one variable that has received considerable attention with regard to its impact on environmental degradation. Environmentalists believe that the desire by countries to maintain their international competitiveness will lead to less stringent environmental policies. Nevertheless, existing studies on the impact of international trade on the environment indicated mixed results. Some studies, for instance, Acheampong et al. (2019). Pham et al. (2020); and Coskuner et al. (2020); concluded that trade openness was detrimental to the environment. Ibrahim and Law (2016) found that the impact of trade openness remains ambiguous as trade openness could be beneficial depending on the effectiveness of institutions. They concluded that trade openness is beneficial to the environment in countries with effective institutions and harmful in countries with weak and ineffective institutions. Ren et al. (2014) blamed China's increasing trade surplus for the rising air pollution observed in the country. With a fixed-effects model and correcting for endogeneity, Bernard and Mandal (2016) confirmed that trade openness had no statistically significant impact on environmental performance even as it increased CO_2 emissions. However, with a GMM estimation, the same study confirmed that trade openness is detrimental to the environment.

Environmental degradation in SSA is further exacerbated by international forces that are often beyond the control of SSA. For instance, the price of exports of SSA, which comprise mainly of unprocessed primary products, are subject to erratic fluctuations in international markets. In other words, SSA regularly confronts declining terms of trade in international markets. As export revenues decline and the pressure to service huge external debts mounts, these countries clear their forests for more cash crops and timber for export, thereby increasing the rate of deforestation. The IMF states that the external debt of the Least Developed Countries (LDCs) has climbed to a record of $744 billion by 2019. The pressure to service the enormous external debts of SSA leads to myopic government policies that are detrimental to the interests of tropical forest conservation (Didia et al., 2018; Kahn & McDonald ,1995; Von Moltke, 1990). Most of the countries in SSA are among the LDCs, and they clear their forests for cash crops and timber for exports to earn the foreign exchange needed to pay for imports and service substantial external debts.

In many cases, the foreign exchange earnings from the export of cash crops and timber cannot even cover the interest rate payments on these debts, let alone the principal. This over-exploitation of tropical forests exacerbates wind and soil erosion and global warming. Predictably, most of the environmental degradation in SSA emanates from tropical deforestation rather than the emission of GHGs such as CO_2 and sulfur dioxide (SO_2) from manufacturing plants.

There appears to be a reasonable consensus in existing studies across the globe that an increase in population or population density is deleterious to the environment regardless of whether the dependent variable is CO_2 emissions,(see, for instance, Abdelfattah et al. (2018); Acheampong et al. (2019); Lin et al. (2017); and Pham et al. (2020); Rahman (2017; Zhou and Liu (2016) or multidimensional measures of pollution such as ecological footprint (Dimnwobi et al., 2021) or the EPI (Bernard & Mandal 2016). This is quite refreshing given the contentious results of studies of this nature. In SSA, there is an influx of residents to the urban centers that can offer employment opportunities and modern amenities such as electricity and potable water. This increase in urban population leads to congestion that exerts unsustainable pressure on the environment. Hence, population density is included in our empirical model.

Another area that has garnered much attention in the literature is the impact of institutions and institutional development on environmental outcomes. In general, most of these studies concluded that well-developed and effective institutions are good for environmental outcomes. Dasgupta and De Cian (2016) carried out an extensive review of fifty-five studies that analyzed

the impact of institutions and governance on a range of environmental outcomes at the national level. They arrived at the following conclusions: (1) Notwithstanding the mixed evidence on the impact of institutions on environmental outcomes, most of the studies reviewed concluded that a positive relationship exists between various indicators of institutional quality and environmental performance. (2) The results of the studies are sensitive to the indicators of institutional quality adopted and the different methodologies and data sources. Hence, it is not surprising that Fiorino (2010) and Strand (2010) concluded that the relationship between institutions and environmental outcomes is ambiguous or inconclusive. However, one clear fact is that no study accessed in this literature review has concluded that effective institutions are detrimental to environmental outcomes**.** Goel and Herraia (2012) examined the impact of institutional quality on environmental pollution in the Middle East and North Africa region (MENA). Their empirical analysis of over 100 countries covering the period 2004-2007 concluded that MENA countries experienced more pollution than the rest of the world. They attributed this outcome to the weakness of institutions, which engendered corruption and the shadow economy.

Similarly, Ali et al. (2019) explored whether the quality of institutions affected environmental outcomes in forty-seven developing countries. Using the dynamic panel generalized method of moments (GMM) estimations, the study concluded that better and more high-quality institutions led to a reduction in CO_2 emissions. Mavragani et al. (2016) examined seventy-five countries comprising of all the G20 and EU countries, which account for about 90% of global trade and investment, and they found that good governance (effective institutions) is suitable for environmental protection.

Utilizing the GMM in examining the impact of institutional quality and trade openness on CO_2 emissions in forty SSA countries, Ibrahim and Law (2016) found that effective institutions are unequivocally good for the environment. Congleton (1992) stated that the nature of political institutions is a significant determinant of environmental policies. The study further concluded that liberal democracies are better custodians of the environment than autocratic regimes, just as Didia (1997) concluded.

Good governance[6]**,** as reflected in the rule of law**,** political stability, government effectiveness, regulation, and level of corruption, impacts environmental outcomes. Several studies have explicitly investigated the impact of corruption on environmental outcomes. Doig and Melvor (1999) carried out a literature review of both empirical and practitioner studies on the impact and control of corruption in the developmental environment. They stated that corruption has "anti-developmental" effects in practically all developing countries as manifested in distorted development priorities, massive human and financial capital flight, and heightened social and political instability. In examining the impact of corruption on environmental policy, Damania et al. (2003) concluded that "corruption weakens the stringency of environmental policies." Analyzing air pollution (CO_2 and SO_2 emissions) in ninety-four countries from 1987-2000, Cole (2007) estimated both direct and indirect impacts of corruption on air pollution. The study concluded that corruption increases per capita emissions. Generally, the rule of law, political stability, quality regulation, and effective government are good for environmental health (World Bank, World Governance Indicators (WGI), 2020). Other studies that concluded that good governance and effective institutions were good for environmental protection included Torras and Boyce (1998) and Sulaiman et al. (2017).

Other variables such as energy consumption, urbanization, financial development, and foreign direct investment have also been explored in the literature as determinants of environmental quality. The general findings of these studies were that urbanization (Pham, et al.

2020); financial development (Acheampong et al. 2019); and energy consumption (especially fossil fuels) (Rahman 2017) led to environmental pollution, whereas renewable energy use (Acheampong et al. 2019) is good for the environment. The jury is still out on foreign direct investment (FDI) as Acheampong et al. (2019) found that FDI is beneficial to the environment while Pham et al. (2020) found otherwise. In any event, these variables are beyond the scope of this study and are therefore excluded from our empirical analysis.

The paucity of data in environmental performance research has led many studies to employ cross-sectional analysis. One drawback of this approach is that both developed and developing countries with different levels of environmental pollution and standards and different levels of socio-economic factors and institutional development are lumped together. It is the case that in available studies such as Cole (2007); Dasgupta et al. (2001), and Ali et al. (2019), OECD countries, other developing countries, and SSA are lumped together. This situation increases the likelihood of encountering omitted variable bias and endogeneity issues, as Dasgupta and De Cian (2016) pointed out. In other situations, SSA and non-OECD areas such as Asia are practically ignored because of gaps in available data (Sonnenfield & Mol, 2006). In either case, assessing the environmental performance of SSA suffers, whereas SSA should be receiving more attention if for no reason than to ensure that SSA learns from the experience of OECD countries and other emerging markets.

Fiorino (2010) concluded that success in the economic and political life of a nation is a prerequisite for environmental progress. This statement, by and large, seems to summarize or approximate the realities in SSA. Does this statement then imply that efforts to protect the environment in SSA are a lost cause? Could this type of reasoning explain why there is a paucity of studies on environmental performance in SSA? This study, therefore, fills the void in the extant literature by examining the factors that impact environmental performance in SSA. Several studies, as cited above, have explored environmental performance in OECD countries and other emerging markets, and they have identified key variables that impact environmental performance. This study, therefore, adds to the extant literature by addressing the question of - to what extent are these variables applicable to environmental performance in SSA? In other words, are the same variables at play in other regions applicable to SSA?

Conceptual Framework

The health of the environment in any nation depends on functional environmental policies and careful management. Hence, environmental performance is a function of socio-economic factors, globalization, governance, and the effectiveness of institutions. By and large, it is hypothesized that economic growth or the lack thereof spurs environmental degradation. For industrialized countries and those experiencing rapid industrialization, the by-products of manufacturing activities - emissions of GHGs such as CO, CO_2, and SO_2 - damage the environment. Global warming and climate change have been linked to these GHGs. In other words, as economic growth accelerates with rapid industrialization, pollution and environmental degradation are inevitable. Furthermore, as globalization intensifies through international trade, countries in a bid to maintain their international competitiveness may disregard or ignore the external diseconomies associated with manufacturing activities.

On the other hand, lackluster economic growth and lack of industrialization mean that the population will depend on their land and natural resources for survival. Hence, intense pressure is exerted on natural resources such as forests, and over-exploitation is expected. For instance, in

SSA, the demand for agricultural land is a significant factor driving tropical deforestation. Other major drivers of tropical deforestation include commercial logging, firewood and charcoal consumption by households and industries, absence of well-defined property rights, and government policies (Barbier et al., 1991; Cropper &Griffiths, 1994; Deacon, 1995; Kahn & McDonald, 1995; Hassan and Hertzler, 1988; Mahar, 1989; Mendelsohn, 1994;**).** Didia et al. (2018) revealed that the pressure to service the enormous external debts of SSA also leads to myopic policies that are detrimental to the interests of tropical forest conservation. Tropical forests serve as carbon sinks that absorb GHGs, thereby mitigating many environmental problems such as global warming, extensive wind and soil erosion, and decline in soil fertility. Hence, the destruction of tropical forests is deleterious to environmental health (Mahar 1989; WRI 1992).

From both extremes (rapid industrialization and lackluster or minimal industrialization), it is clear that the production of goods and services results in detrimental outcomes to the environment. Furthermore, globalization and international competitiveness impact the environment just as governance and institutions. Hence, the factors impacting environmental quality can be covered in five broad areas: economic growth, globalization, social factors, governance, and institutions. Therefore, our regression model can be broadly stated as follows:

EPI = f(economic growth, globalization, social factors, governance, institutions) **……..** *(1)*

where EPI, the dependent variable, is a measure of environmental sustainability; economic growth is captured by per capita GDP; globalization captures attempts by different countries to maintain or gain international competitiveness in trade; social factors capture pressures on the environment resulting from the population or population density; governance captures governance indicators as measured by the rule of law, political stability, government effectiveness, regulation and level of corruption; institutions represent the effectiveness of institutions. From the above, we may now specify our model as follows:

EPI = f(GDP, debt service, trade openness, population density, governance, institutions) ……. (2)

The specific definitions and operationalization of these variables are discussed in the next section.

Data and Methodology

From equation (2), the basic model estimated in this study is given as:

EPI = f (RGDP, Debt, Tropen, Popden, Govn, Inst) **…… (3)**

Where,

EPI	=	*Environmental Performance Index*
RGDP	=	*Real gross domestic product per capita*
Debt	=	*Public debt per capita*
Tropen	=	*Trade openness measure (imports + exports)/GDP*
Popden	=	*Population Density (number of people per square mile).*
Govn	=	*governance proxied by political stability, the rule of law, government effectiveness, regulatory quality, and control of corruption.*
Inst	=	*Institution (index of effectiveness of institutions).*

Therefore, equation (3) can be more specifically written as follows:

$$EPI = \beta_0 + \beta_1 RGDP + \beta_2 TROPEN + \beta_3 DEBT + \beta_4 POPDEN + \beta_5 GOVN + \beta_6 INST + \varepsilon \text{ ------- } \mathbf{(4)}$$

A priori, the following relationships would be expected:

$\delta EPI/\delta RGDP < 0$; $\delta EPI/dDEBT < 0$ $\delta EPI/\delta TROPEN > 0$ or <0:

$\delta EPI/\delta POPDEN < 0$; $\delta EPI/\delta RGOVN > 0$ or < 0; $\delta EPI/\delta RINST > 0$

Data were collected from a cross-section of forty-two countries in SSA. The dependent variable in this study is the environmental performance of a nation. In this case, we adopt the Environmental Performance Index (EPI), which is published by the Yale Center for Environmental Law and Policy (YCELP). EPI is a data-driven summary of the state of sustainability around the world. It is comprised of seventy-four (74) variables, with seventy-seven percent (77%) being environmentally related and twenty-three percent (23%) non-environmentally related. The EPI used for this study was for the year 2018. Following previous studies, this study equally undertook regressions with CO_2 emissions as the dependent variable. The data on CO_2 emissions (measured in metric tons per capita) come from the World Bank. The EPI is a more comprehensive measure of environmental health, whereas the CO_2 emissions comprise only the emissions of one global pollutant.

The data on socio-economic variables such as GDP, public debt, population density, and trade openness come from the World Bank. The governance variables (political stability, the rule of law, government effectiveness, regulatory quality, and control of corruption), and institutional quality, come from the World Governance Index (WGI) published by the World Bank. These governance indicators are derived from over thirty individual data sources produced by various survey institutes, think tanks, non-governmental organizations, international organizations, and private sector firms. All the governance indicators used in this study had a data range from -2.5 to +2.5, with higher numerical values indicating better performance (Governance Indicator Project, World Bank 2020). The data collected were constrained by missing observations as many countries in SSA are marred by political instability leading to civil strife and wars.

It is important to note that environmental performance as reflected in the EPI and CO_2 emissions and the governance indicators used in this study have a short history in SSA as opposed to more developed countries in Europe and North America that have been keeping data for some time. The study adopts the Generalized Method of Moments (GMM) estimation technique due to inherent endogeneity issues in the data. In addition, the data come from a cross-section of countries with varying levels of economic development and environmental policies. Furthermore, the variables have been scaled to mitigate the overpowering effect of sheer sizes where appropriate. Hence, GMM is a robust and appropriate estimation technique in this situation.

Table 1 presents the descriptive statistics of the variables, while Table 2 presents the correlation matrix.

Table 1: *Descriptive Statistics*

Variable	Obs	Mean	Std. Dev.	Min	Max
epi2018	42	45.0450	7.9128	27.4300	66.0200
govteffect~s	42	-0.7455	0.6386	-1.7204	0.8761
rule of law	42	-0.6430	0.5988	-1.7842	0.7797
GDP growth	42	3.6438	2.9613	-6.3563	8.5697
GDP/capita	42	2565.9500	3337.6230	210.8042	14417.0600
Debt/capita	42	1420.405	2011.022	86	9308
Debt/GDP	42	0.5859	0.3260	0.1212	2.1208
trade/GDP	42	0.7329	0.3564	0.2259	1.8235
popudensity	42	105.8853	133.5676	2.9737	623.3020
politicals~y	42	-0.5925	0.8420	-2.2813	0.9792
regulatory~y	42	-0.6481	0.5678	-1.6303	1.0272
controlcor~n	42	-0.6377	0.6553	-1.5597	0.7682
voiceaccou~y	42	-0.4750	0.7223	-1.8645	0.9977
institutio~h	35	3.0286	0.4322	2.0000	4.0000

Table 2: *Correlation Matrix*

	govtef~s	ruleof~w	polit~y	regul~y	contr~n	gdpper~a	Debt-capita	tradegdp	popud~y	instit~h
govteffect~s	1.00									
ruleoflaw	0.9065	1.00								
politicals~y	0.6158	0.6846	1.00							
regulatory~y	0.8541	0.8385	0.5223	1.00						
controlcor~n	0.8705	0.8787	0.6748	0.7780	1.00					
GDP/capita	0.5193	0.4081	0.3954	0.2592	0.4775	1.00				
Debt/capita	0.0633	0.1785	0.2640	-0.0299	0.2027	0.0711	1.00			
tradegdp	0.2419	0.1665	0.4653	0.0989	0.3091	0.5422	0.0298	1.00		
popudensity	0.3235	0.2973	0.1504	0.3298	0.2541	-0.0095	-0.0811	-0.1954	1.00	
institutio~h	0.7268	0.6610	0.2903	0.6552	0.6071	0.2289	0.0949	-0.0652	0.1417	1.00

Empirical Results and Discussion

For our empirical estimations, we utilize the GMM estimation technique. We undertake two estimations with EPI and CO_2 as dependent variables.

Table 3 displays the GMM parameter estimates with EPI as the dependent variable. Five models of the basic regression equation are presented as models A through F. The difference in the models arises from the introduction of the governance variables – Rule of Law, Govt. Effectiveness, Political Stability, Regulatory Quality, Corruption, and Institutional Strength. Each of these variables is designed to capture the influence of governance on environmental quality.

Since governance is rather complex, it is represented by multiple proxy variables, reflecting various government functions. These variables are highly correlated as expected (see the Correlation Matric – Table 2). Collectively, these proxy variables show the overall effectiveness of a sovereign government, in charge of managing the state affairs, directly and indirectly affecting the environment. The governance proxy variables in the study are, therefore, staggered into the model equation one at a time, beginning with Model A, thereby minimizing estimation biases associated with multicollinearity. Collectively, the regression equations (Models A - F) with different governance variables tell a whole story.

Considering individual regressors, it is clear that GDP is a significant determinant of environmental quality. The variable RGDP is positively and statistically significant at the 0.01 level in all the six regression models. This implies that the growth of income enhances environmental health in SSA. For instance, an increase in capita per income of about $1000.00 will increase between 1 – 2 points in the EPI index in the six models in Table 3, *ceteris paribus*. This result appears contrary to the findings of Bernard and Mandal (2016**)** that reveal a negative relationship between income growth and environmental performance in a cross-section of countries in Asia, Latin America, Europe, and Africa. This is a noteworthy divergence in results because Bernard's and Mandal's study is one of few studies that used the EPI as the dependent variable, unlike most previous studies that employed CO_2 as the dependent variable. However, this divergence in the results of these two studies is not entirely surprising because Bernard's and Mandal's data is dominated by more advanced manufacturing economies that polluted first and sought mitigation measures later.

On the contrary, it can be argued that countries in SSA that are just beginning to industrialize are more mindful of the negative environmental externalities given the level of international awareness of the harmful effects of the unbridled pursuit of growth in GDP. Besides, the availability of new technologies and cleaner means of production mean that increased GDP and a cleaner environment are not mutually exclusive, as the empirical results have confirmed in SSA. In addition, the result here does not lend any support to the EKC hypothesis but instead lends support to recent studies such as Stern (2004) and Rahman (2020).

The other socio-economic regressors – trade openness (TROPEN), DEBT, and population density (POPDEN) – are not statistically significant. However, these results are not entirely surprising since SSA accounts for about a paltry 2 percent (2%) of world trade in goods and services, and most of the continent is still populated by rural dwellers. Urbanization is increasing, but most of SSA's population lives in rural communities.

Turning to the governance variables proxied by the rule of law, government effectiveness, political stability, regulatory quality, the incidence of corruption, and institutional strength, we have a mixed bag of results. The parameter estimates of the rule of law in model A, and government effectiveness in model B (Table 3), are positively and statistically significant at the 0.05 and 0.10 levels of significance, respectively. This implies that as the rule of law takes hold and the government becomes more effective, the sustainability of the environment is no longer relegated to market forces alone as the government intervenes as necessary. In other words, the entrenchment of the rule of law and government effectiveness creates an environment propitious to environmental sustainability. For instance, a one-point increase in the Rule of Law or Government Effectiveness index leads to about 4-point increase in EPI. This is a huge and consequential impact and this outcome supports the findings of Bernard and Mandal (2016). The other governance indicators are not statistically significant.

Table 3

GMM estimations with EPI as the dependent variable (p-values in parentheses)

Independent Variables	**Model A**	**Model B**	**Model C**	**Model D**	**Model E**	**Model F**
Constant	45.37315 (0.000)	45.49869 (0.000)	43.30736 (0.000)	42.1268 (0.00)	42.13349 (0.000)	39.46603 (0.000)
RGDP	.00120 (0.003)***	.00120 (0.003)***	.00138 (0.000)***	.00154 (0.000)***	.00141 (0.000)***	.00213 (0.000)***
TROPEN	-.20092 (0.949)	-.70287 (0.805)	-1.81210 (0.519)	-1.06390 (0.711)	-.48783 (0.816)	-3.46443 (0.240)
DEBT	.00027 (0.452)	.00035 (0.356)	.00019 (0.635)	-.00002 (0.945)	.00030 (0.446)	.00056 (0.265)
POPDEN	-.00848 (0.215)	-.00784 (0.331)	.00095 (0.908)	.00118 (0.903)	.00092 (0.910)	.00250 (0.845)
Rule of Law	4.43704 (0.026)**					
Govt. Effectiveness		3.62182 (0.085)*				
Political Stability			1.28143 (0.416)			
Regulatory Quality				.54352 (0.781)		
Corruption					1.11644 (0.456)	
Institutional Strength						1.04662 (0.691)
No of Observations	42	42	42	42	42	42
GMM criterion Q(b)	0.007	0.047	0.102	0.166	0.117	0.106
GMM weight matrix	robust	robust	robust	robust	robust	robust

* p<0.10 level, ** p<0.05 level, *** p<0.01 level

Table 4

GMM Estimations with CO_2 as the Dependent Variable (p-values in parentheses)

Independent Variables	**Model A**	**Model B**	**Model C**	**Model D**	**Model E**	**Model F**
Constant	.2615096 (0.602)	.4572024 (0.486)	.9123948 (0.095)	.4288485 (0.413)	.5085843 (0.345)	-1.613441 (0.036)
RGDP	.0003368 (0.001)***	.0003148 (0.003)***	.0003654 (0.001)***	.0004102 (0.000)***	.0003931 (0.001)***	.0003295 (0.000)***
TROPEN	.349175 (0.424)	.3520688 (0.414)	-.1656409 (0.750)	-.0173649 (0.972)	.069409 ((0.889)	.442567 (0.236)
DEBT	-.0002926 (0.079)*	-.0003043 (0.075)*	-.0003909 (0.044)**	-.0003303 (0.074)*	-.0003655 (0.049)**	-.0001132 (0.111)
POPDEN	-.0001533 (0.914)	-.000211 (0.881)	.0002195 (0.889)	.0001008 (0.951)	.0003054 (0.840))	.0012666 (0.254)
Rule of Law	.-05870 (0.862)					
Govt. Effectiveness		.1030866 (0.797)				
Political Stability			.2838344 (0.151)			
Regulatory Quality				-.0654414 (0.848)		
Corruption					.0488126 (0.867)	
Institutional Strength						.5221044 (0.023)**
No. of Observations	42	42	42	42	42	42
GMM criterion Q(b)	0.039	0.040	0.021	0.001	0.006	0.013
GMM weight matrix	robust	robust	robust	robust	robust	robust
* p<0.10 level, ** p<0.05 level, *** p<0.01 level						

In line with an overwhelming majority of previous studies on environmental degradation as discussed in the literature review, we execute regressions with CO_2 as the dependent variable. This allows for a comparative analysis of our results from SSA with the results from other countries. Table 4 displays the GMM estimations with CO_2 as the dependent variable. CO_2 is measured in metric tons per capita. Just as in Table 3, it is apparent that GDP is a significant determinant of environmental health in SSA. The coefficients of RGDP are positively and statistically significant at the 0.0l level in all six models implying that the growth in income leads to more CO_2 emissions, which is detrimental to the environment in SSA. This outcome supports the findings of most of the earlier studies focusing on OECD countries and other emerging markets. The difference in outcome between the two dependent variables - EPI and CO_2 - is not a cause for alarm as the EPI is a comprehensive measure of environmental sustainability. In contrast, CO_2 measures the impact of just one global pollutant.

Unlike Table 3, where the debt burden was not statistically significant in any of the models, we find that the debt burden became negatively and statistically significant in models A through E in Table 4, implying that as the debt burden increases, CO_2 emissions decrease. The negative sign of the parameter estimate of debt is a bit surprising. This parameter estimate implies that a $1 increase in per capita debt leads to a decrease in CO_2 emissions of about 0.0003 to 0.0004 metric tons per capita. This translates to a decrease in CO_2 of between 0.3kg to 0.4kg or 0.68 to 0.90 lbs. per capita (1 metric ton = 1000kg or 2252 lbs.). Although this outcome is beneficial to the environment, the question then becomes - why or how does this occur? A plausible explanation is that as the level of debt goes up, these countries may choose to simultaneously invest some of the debt proceeds in environmental protection – in this case, tropical forest conservation. Alternatively, it is plausible that the debt proceeds relieve the pressure on myopic government policies that are detrimental to the interests of tropical forests, the depletion of which accounts for most of the CO_2 emissions in SSA. It could also be that some portion of the debt is used to consume imports or to finance other government budget deficits. This expenditure line relieves the pressure on home production and government revenue generation, thereby mitigating the pressure on tropical forests, which are the main sources of livelihood in SSA. In any event, we can reasonably conclude that the debt proceeds were not invested in manufacturing firms as the state of manufacturing in SSA attests to. The debt burden appears to have an indirect or inadvertent effect that benefits the environment.

Surprisingly, in Table 4, none of the governance indicators is statistically significant in models A-E. However, institutional strength, which combines or reflects the aggregate strength of the governance indicators, is positively and statistically significant at the 0.05 level in model F. The positive sign, which indicates that CO_2 emissions increase as institutional strength increases, is puzzling nonetheless. Ordinarily, one would expect that an increase in institutional strength would be favorable to the interests of environmental conservation, thereby lowering CO_2 emissions. The plausible explanation for this unexpected impact of institutional strength could be that as institutions become more entrenched and effective, more of the production taking place in the underground or informal sector now move to the formal sector, thereby resulting in more CO_2 emissions recorded at least in the short run. This outcome is analogous to the findings of Goel and Herraia (2012) and Mehdi (2016) which surprisingly concluded that corruption has a positive and statistically significant impact on environmental quality. They explained that as the level of corruption increases amid weak and non-existent institutions, many polluters leave the formal sector and move underground to the informal sector, where their polluting activities are no longer

observed and recorded. This, in turn, inadvertently impacts environmental health calculations favorably.

On the whole, the results from Tables 3 and 4 indicate that the level of economic activity (GDP), debt burden, and governance (as captured by the rule of law, government effectiveness, and institutional strength) are major determinants of environmental health in SSA. Surprisingly, such factors as globalization proxied by trade openness, and urbanization which are easy villains in more advanced economies, are nonfactors in environmental degradation in SSA.

Summary and Conclusions

Environmental degradation is taking place at an alarming rate globally, and SSA is not an exception. While the leading cause of environmental degradation in the OECD and other industrialized countries is emissions of GHGs such as CO_2 and CO from manufacturing activities, environmental degradation in SSA results mainly from tropical deforestation. Although a few countries in SSA are endeavoring to kick-start manufacturing activities, manufacturing is still very modest and inconsequential. Hence GHGs emissions from manufacturing do not pose the same risks to the environment as in OECD countries and other emerging markets. Despite the realization that SSA is experiencing unsustainable environmental degradation, most environmental health studies have focused mainly on OECD countries and other emerging markets. These studies have used data from a mixture of developed and developing countries in a few cases. Notably, one glaring deficiency in these studies is the neglect of SSA, not minding that some of the world's fastest-growing economies are in SSA. Sonnenfeld and Moi (2006) state that SSA and other developing regions have been neglected in most existing studies due to data paucity. Furthermore, SSA is the depository of many of the world's critical natural resources needed by industries in the developed world. With fledgling democracies, political instability, rampant corruption, weak and non-existent institutions, and extreme poverty, it is imperative that the factors leading to the degradation of the environment in SSA be examined.

This study, therefore, fills this void by exploring the factors leading to environmental performance in SSA. Utilizing data from 42 countries in SSA and covering the period 1970-2018, our empirical estimations revealed that the primary determinant of environmental performance in SSA is the level of economic activities. The results showed a statistically significant positive relationship between economic activities (GDP per capita) and environmental performance, as displayed in Table 3. In other words, as the level of GDP increases, the level of environmental performance improves. This outcome does not support the existence of the EKC in SSA. It could be that SSA countries have learned from the experience of OECD countries and have decided to safeguard their environment simultaneously with the pace of economic activities. However, Table 4 indicates that income growth is detrimental to the environment, leading to more CO_2 emissions. This outcome supports the findings of earlier studies that equally employed CO_2 as the dependent variable. The difference in outcome between the two dependent variables – EPI and CO_2 - is not a cause for alarm as the EPI is a comprehensive measure of environmental sustainability. In contrast, CO_2 measures the impact of just one global pollutant.

The debt burden appears to have a mitigating impact on CO_2 emissions while having no impact on the EPI's comprehensive measure of environmental sustainability. A plausible explanation is that as the level of debt goes up, these countries may choose to simultaneously invest some of the debt proceeds in environmental protection – in this case, tropical forest conservation. Some of the debt proceeds could also be used to finance imports or government deficits which

relieves the pressure on tropical forests that constitute the primary source of government revenue in SSA. Hence, debt proceeds relieve the pressure on myopic government policies that are detrimental to the interests of tropical forests, the depletion of which accounts for most of the CO_2 emissions in SSA. As we stated earlier, a $1 increase in debt per capita results in 0.3kg to 0.4kg or 0.68 lbs to 0.90 lbs reduction in CO_2 emissions per capita.

Two governance variables - the rule of law and government effectiveness - signifying the impact of government show a statistically significant positive relationship with environmental performance. At the same time, political stability, corruption, and regulatory quality are not statistically significant. This mixed bag of results could reflect the level of institutional development in SSA. Amid fledgling institutions, the government of the day may decide to strengthen some institutions based on public pressure and agitations or other factors to the detriment of other institutions. For instance, public pressure may force a government to invest more in fighting corruption while neglecting to deepen regulatory quality due to budgetary constraints or other factors. Institutional strength, which combines or reflects the aggregate strength of the governance indicators, is positively and statistically significant in Table 4. The plausible explanation for this surprising impact of institutional strength could be that as institutions become more entrenched and influential, more of the production taking place in the underground or informal sector now move to the formal sector, thereby resulting in more CO_2 emissions being recorded.

Trade openness and population density did not have any statistically significant impact on environmental performance. This is not surprising as SSA's share of world trade is about a paltry 2 percent (2%), and even though the rate of urbanization is accelerating, most of the population in SSA still live in rural areas.

Two recommendations emerge from this study. First, deliberate and concerted efforts to enhance income growth in SSA will be a welcome development in mitigating environmental degradation. Hence, increased foreign direct investment inflows to SSA are needed to create more jobs for the teeming population and reduce the pressure on tropical forest resources and the environment. Second, developing countries drowning in debt may need debt forgiveness or debt relief from OECD and other industrialized countries since the debt mitigates environmental degradation, which results from tropical deforestation and the emission of GHGs.

This study has some limitations. First, we employ cross-country data, and the aggregate results obtained may differ if individual countries were analyzed in time-series studies. Second, we employ an ad hoc regression model, as there are no standard models for studies of this nature. Hence, a study may employ relevant variables at the time of the study, while other studies may pick different variables. Consequently, conflicting results may occur as the likelihood of omitted variable bias is magnified. Therefore, this study recommends that future studies examine individual countries in time-series studies and employ more variables than we have utilized in this study.

Endnotes

1. The Paris Agreement is a multilateral, legally binding international agreement aimed at limiting global warming. It was signed at COP 21 in Paris at the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC). This agreement was entered into on December 12, 2015, and became effective on November 4, 2016. It is hailed as a landmark agreement because, for the first time, a binding agreement was entered into to reduce

global warming. As of February 2021, there are 196 parties to the agreement. For more information, see: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

2. The Kyoto Protocol was an international agreement adopted on December 11, 1997, in Kyoto, Japan, that established binding targets and measures to address climate change resulting from the emission of greenhouse gases. Currently, there are 192 Parties to the Kyoto Protocol. (https://www.google.com/search?q=kyoto+protocol)

3. The Rio Summit or Earth Summit was a conference on environment and development organized by the United Nations. The conference was held in Rio de Janeiro, Brazil, on June 3-14, 1992, to discuss ways to reconcile economic development and environmental conservation. (https://www.britannica.com/event/United-Nations-Conference-on-Environment-and-Development)

4. Sustainable Development Goals (SDG) are 17 goals adopted by member states of the United Nations in 2015. These goals provide a blueprint for achieving peace and economic growth for all members and cover areas such as improving health and education, reducing inequality, and environmental protection (https://sdgs.un.org/goals).

5. The Millennium Development Goals (MDG) are eight goals articulated by the United Nations and all the leading development institutions "which range from halving extreme poverty rates to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015" (https://www.un.org/millenniumgoals/)

6. Broad dimensions of governance:

Rule of Law = An index of the law's supremacy and predominance.

Political stability = An index of the level of political stability and absence of violence/terrorism.

Government Effectiveness = An index of the level of effectiveness of the government.

Regulation quality = An Index of the effectiveness of government regulation.

Corruption = An index of the level of control of corruption.

(https://info.worldbank.org/governance/wgi/)

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