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Management of various socio-economic factors under the United Nations sustainable development agenda

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ABSTRACT

The objective of the study is to assess the United Nation's healthcare sustainable development agenda by controlling the number of socio-economic and environmental factors, including carbon emissions, particulate emission damages, natural resource depletion, communicable diseases, and per capita income in a panel of 40 Sub-Saharan African (SSA) countries. The study covered a time period of 2000–2016 for robust inferences. The pooled Mean Group (PMG) estimator is used to controlled possible heterogeneity and cross-sectional dependence. The results confirmed the inverted U-shaped relationship between per capita income and natural resource depletion, while the U-shaped relationship is found between communicable disease and per capita income. The long-run results confirmed that communicable diseases and particulate emission damages both negatively linked with the country's per capita income, while there is a direct association between per capita income and carbon emissions across countries. The results further reveal that particulate emission damages and high mass carbon emissions largely associated with the communicable diseases that need sustainable healthcare policies to delimit carbon-particulate emissions growth in a panel of SSA countries. The undeniable health losses and low adaptability of environmental sustainability reforms lag behind the SSA countries from the assigned target of United Nation's sustainable development goals, which need national and international collaborations to designed better healthcare policies to prevent from infectious diseases that lead towards sustained global healthcare infrastructure.

1. Introduction

Healthcare sustainability is the focal point agenda of the United Nation that can be achieved by delivering high quality medical care with improve ecosystem. The communicable diseases are considered the leading killer of children and young adults that account of 14 million deaths per year worldwide. Infectious and parasitic diseases are the leading cause, which is associated with poor environmental conditions and high incidence of poverty. This serious issue needs healthcare sustainability reforms to legitimate health policies for broad-based growth (WHO, 2005). The United Nation Sustainable Development Goals (SDGs) is the milestone that has to be achieved by their member countries till 2030 for transformation of the world in a better way through shared prosperity. It was presented in the 17th anniversary of United Nation, New York at 25–27th September 2015. The SDGs are the extension of Millennium Development Goals (MDGs) that was wrapped up in 2015. The countries although progress substantially in many goals, however, some counterparts still lag behind due to deprived economic resources. Sub-Saharan Africa is the exemplified case study that lags behind the sustainable targets due to socio-economic and environmental factors, which need strong policy intervention to achieve SDGs (UNECA, 2015). Sustainable development policies largely attract the developing and developed countries in order to reshape their environmental legislation (Aflaki et al., 2018). The sustainable development goals (SDGs) 3, 12 and 13 is related with healthcare infrastructure (morbidity and mortality), sustainable production and consumption and climate change respectively, which is set out for this study to evaluate the progress of SSA countries towards SDGs. African economies is largely affected by

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communicable and non-communicable diseases, air pollutants, particulate emission damages, natural resource depletion, and sustainable consumption and production, which need long-term green policies to mitigate environmental issues (SDGCAFRICA, 2017).

The SDGs contain 17 goals, which contain 232 indicators and 169 targets; however, Africa's 62% data is not traceable due to serious data limitations. The Sub-Saharan African (SSA) region strive hard to achieve SDGs, for instance, during the last 15 years, the region substantially dropped under −5 mortality rate up to 46%, which is faster than any other region of the World (Brookings, 2018). Despite certain improvement in African economies towards the Millennium Development Goals (MDGs), the region still deprived with poverty, hunger, malnutrition, gender inequality, environmental issues etc, which have to combat with sustainable policy instruments to achieve SDGs till 2030. The earlier literature is widely documented on environmental sustainability across the globe, i.e., Salim et al. (2014) analyzed the green energy reforms in a panel of OECD countries for a period of 1980–2011, and found the existence of long-run relationships among renewable energy, non-renewable energy, industrial value added, and economic growth. The results further comprehend the causality relationship among the stated factor in different causal channels, for instance, the causality is running from economic growth to renewable energy that confirmed the growth-led energy demand across countries. The results further confirmed the two-way linkages among industrial value added, renewable and non-renewable energy demand. The study emphasized the need to develop green energy infrastructure in order to improve economic activities that supports the environmental sustainability agenda across countries. Salim and Shafiei (2014) further extended the analysis by examining the role of renewable and non-renewable energy demand in achieving energy efficiency by utilizing population, economic growth, industrial value added, and services value added in a panel of OCED countries for a period of 1980–2011. The results confirmed the positive association of the aforementioned factors across countries. The study conclude that energy efficiency is vital for improving socio-economic and environmental infrastructure, which is deem desirable for moving towards sustainable development reforms across countries. Liu et al. (2016) emphasized the need to decrease under −5 child mortality rate with child survival policy and initiate programmes for life saving interventions to achieve child health related SDGs across the globe. Dos Santos et al. (2017) argued that improved water drinking resources remains one of the critical global challenge that faced most severally less developed countries, including SSA region due to high population growth, urbanization, poor institutions, lack of governance, and weak political justice that led down towards water scarcity issues across countries. Bongaarts and Hardee (2017) concluded that African economies amplify the need to increase public health spending to promote family planning in order to meet the demand of modern contraceptive to reduce health related issues. Asongu et al. (2016) argued that modern technologies played a vital role to improve individual's life and its earning abilities that promote inclusive human development, which is somehow positively interacted in SSA region, where mobile phones technology and governance indicators simultaneously interact to reduce poor vulnerabilities in order to strengthen its earning abilities that is one of the crucial step for human development. Mikulčić et al. (2016) conducted the short assessment of past studies about environmental sustainability and human welfare modeling and concluded that both the factors have a direct relationship between them, which is imperative to go-for-green policies. Fowkes et al. (2016) discussed three unwanted infectious diseases in the context of Africa, which more prone to women and children, i.e., the risk of HIV/AIDS, malaria and tuberculosis remains highly infectious diseases, which severally affected pregnant women and infants. Thus the sustainable policy solution is to enforce the integrated antenatal care models to ensure advances in maternal health to achieve health related SDGs. Tusting et al. (2017) emphasized the need to improve housing quality that helpful to decrease malaria parasitic infections and its exposure to biting. Mberu and Ezeh (2017) discussed the negative consequences of high population growth and population density in Botswana and Zambia, the two member countries of SSA region, and concluded that countries sustainable development depends upon voluntary family planning, women empowerment, reduction in child and maternal mortality rate, and poverty reduction. Thus demographic transition largely affected country's sustainable development programmes, which need serious policy intervention to reduce by integrated healthcare facilities. Saghir (2017) discussed the importance of sustainable infrastructure in SSA countries that protects natural resources and environment, which is imperative for long-term sustainable development of a region. Das and Shaw (2017) argued that sustainable supply chain design is imperative for lessen the environmental pollution, which could be achieved by handling the material, production process, transportation, and emissions in optimized way.

Inglesi-Lotz and Doagn (2018) considered a panel of 10 SSA countries for a period of 1980–2011 and found that non-renewable energy source is the real threat to country's sustainable development, which amplify high scale carbon emissions, while inclusion of renewable energy mix substantially helpful to reduce carbon emissions and improve air quality indicators. The countries should reduce the dependence on imported oil and fossil fuel energy, while inclusion of biofuel energy, solar energy, and many other renewable energy sources should be optimized for sustainable energy generation. Hamilton and Kelly (2017) considered a panel of 5 SSA countries in order to assess the carbon equivalent emissions over a time horizon and found that up to 2030, the economies are unable to reduce carbon equivalent emissions level below the 2012 emission rate, however, by meeting a demand of 50% inclusion of renewable energy supply targeted by 2030, it will substantially be reduced carbon equivalent emissions from 45% to 35%. Adjiwanou and Engdaw (2017) considered a case of 12 SSA countries to evaluate under −5 child mortality rate, which involves toxic chemicals and pathogens that cause healthcare problems. For this intervention, the study developed a household's healthcare hazard model, which controlled 6 critical factors, including water source, sanitation/toilet facility, material used in flooring, wall type, roof, and cooking fuel. The results show that among 12 countries, there are 9 countries where child mortality is accounted for those 6 critical factors, while controlling these hazards, the child mortality still pervasive in 4 countries. The results further show that the risk of child mortality is pervasive during 24–59 months due to intervention of these 6 covariates in 8 countries. Thus, it is imperative to invest in healthcare infrastructure by public-private partnerships and media campaigns to reduce child mortality by water and sanitation facilities, water resources, housing structure, and better cooking fuel used. Lee et al. (2018) emphasized the need to include biofuel and biogas in energy mix in order to mitigate GHG emissions for achieving sustainable development. Hanif (2018) considered a panel of SSA countries to evaluate environmental impacts of health during a period of 1995–2015 and found that solid fuels that is used in cooking fuels and fossil fuel energy demand both are the bad indicators for child health and increase risk of tuberculosis across countries. The results conclude that reduction of non-renewable energy sources substantially reduce anthropogenic activities, which were largely responsible to increase mortality rate across countries. Amegah and Agyei-Mensah (2017) described the vulnerable situation of air pollution in the cities of SSA countries; which is mainly drive by large vehicle ownership, high population growth, solid fuels consumption, inadequate practices of waste management, and industrial progression. All these factors largely increase ambient air pollution that severally threat to human health across countries. Price et al. (2018) discussed the human cost modeling by analyzing the infectious and non-communicable disease, in one of the landlocked southeastern African country, i.e., Malawi, and argued that country severally affected by high risk of diabetes, obesity, hypertension, and multimorbidity condition, which need strong policy intervention to reduce human cost modeling by interactive healthcare international policies. van Gemert et al. (2018) considered the low income SSA countries to assess the healthcare related issues, among which pulmonary disease get a lion share in terms of high risk of prevalence and it lead towards mortality across countries. There is multiple reasoning of the incidence of pulmonary disease, i.e., expensive inhaled medication, tobacco smoking, and poor healthcare infrastructure. In addition, the countries further exposed with some other risk factors, including incidence of tuberculosis, malnutrition, low broth weight, outdoor pollution etc. The study confined the need to improve health standards as per WHO guidelines and provide subsidize healthcare facility through public-private partnership and health insurance.

On the basis of above significant discussions, it is evident that environmental impacts of health is quite high in SSA countries, which need sustainable policy instruments to fight against communicable and non-communicable diseases, environmental pollutants, and natural resource balance. This study has a novel contribution in the African's sustainable development agenda in multiple perspectives; first, the study identified the major factors that influenced country's economic health agenda by including varied nature of economic and environmental factors, i.e., natural resource depletion, particulate emissions damages, carbon emissions, communicable diseases, and economic growth. The earlier literature limited with some non-communicable diseases in the African perspectives (see, Hunter-Adams et al., 2017; Nugent et al., 2018; Rother et al., 2020, etc), further a very limited work is found for resource depletion and communicable diseases (see, Chang and Wei, 2019), particulate emissions damage and communicable diseases (see, Saleem et al., 2019; Adesina et al., 2019, etc), carbon emissions and communicable diseases (see, Abebe et al., 2015; Sylla et al., 2017, etc), and economic growth and communicable diseases (see, Barr et al., 2018; Bickler et al., 2018, etc). This study amalgamate different economic and environmental issues to comprehend more logical means across African countries that is the clear missing link in the given literature, which is filled in this study with sustainable policy factors for sound inferences. The study strives hard to evaluate the possible dynamics between socio-economic and environmental sustainability and their resulting impact on healthcare related issues in a panel of 40 selected SSA countries. The more specific objectives are as follows:

i) To what extent human cost modeling in terms of health related diseases influenced with ambient air pollution.
ii) To analyze the impact of environmental resource depletion, communicable disease, particulate emission damages, and high scale carbon emissions on country's per capita income.
iii) To evaluate the impact of resource depletion, particulate emission damages, and country's per capita income on healthcare modeling, and
iv) To examine the cause-effect relationship and inter-temporal forecasting among the selected factors.

These objectives required sound empirical exercise to device strong policies for sustainable development across African countries.

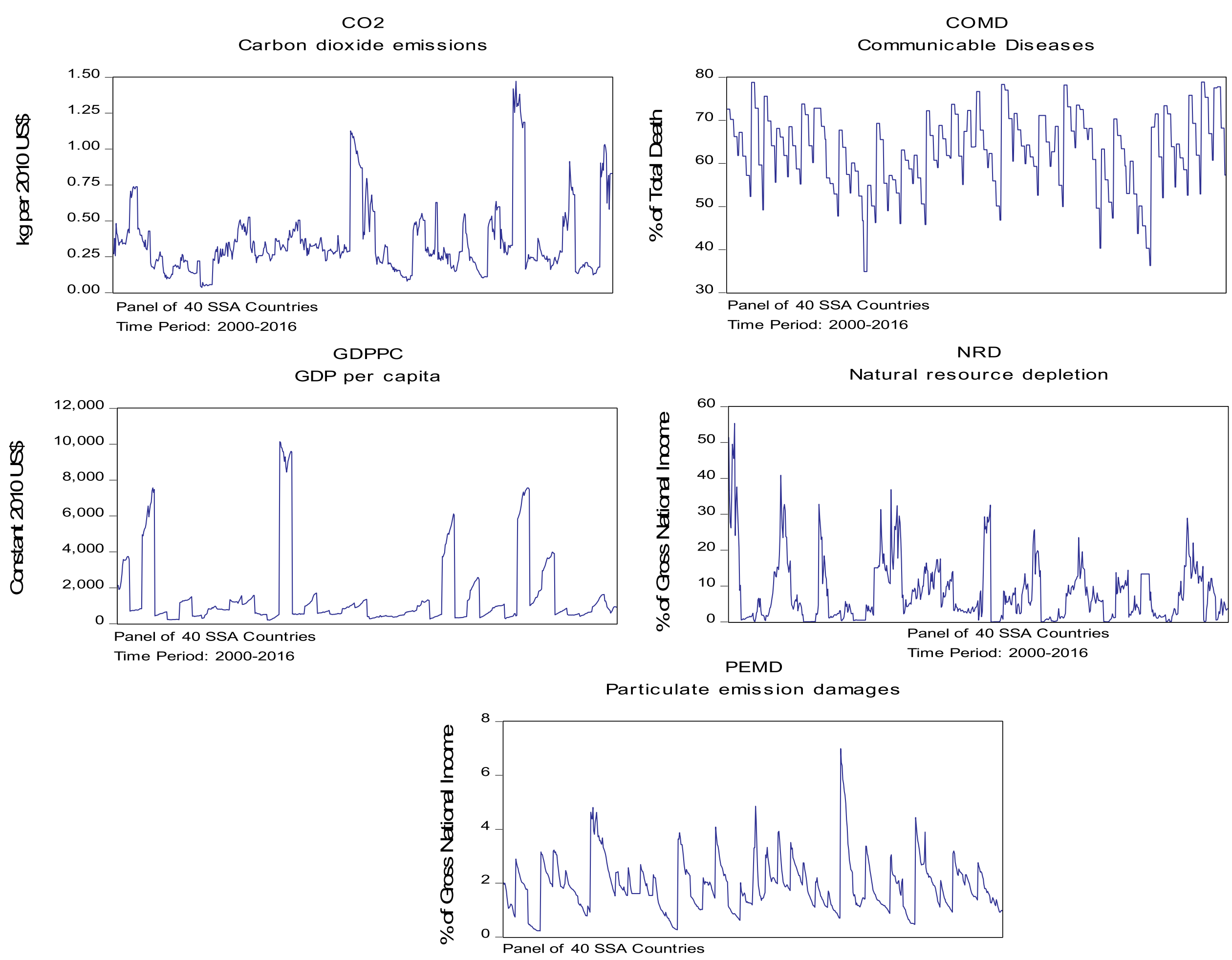

Fig. 1. Level data plots
Source: World Bank (2017).

The study has following sections, section −1 presented introduction of the study, followed by data source and methodology in section −2. Results are discussed in section 3. Section 4 concludes the study.

2. Data source and methodology

The annual data set is collected of 40 Sub-Saharan African (SSA) countries for the following candidate variables, i.e., natural resource depletion (denoted by NRD) as % of GNI, particulate emission damages (denoted by PEMD) as % of GNI, causes of death by communicable diseases (denoted by COMD) as % of total death, carbon dioxide emissions (denoted by CO2) as kg per 2010 US$, and per capita income (denoted by GDPPC) as constant 2010 US$. The last 17 years data is taken from World Bank (2017) for robust inferences, covered a period of 2000–2016. The data requirement limit our study analysis for entire SSA countries, while preceding and succeeding values are used to fill the data series of the respective variables, where required. Table –A in appendix shows the list of selected SSA countries. The SSA region is selected to evaluate healthcare reforms and environmental sustainability agenda due to multiple facets, i.e.,

i) Inadequate healthcare infrastructure leads to increase the number of deaths by communicable and non-communicable diseases (Mensah et al., 2015, etc).
ii) High environmental damages in the form of massive CO2 emissions that sabotage the process of environmental sustainability agenda across Africa (Inglesi-Lotz and Dogan, 2018).
iii) Particulate emissions damage lead to foregone the labor income and it increase the causes of death that further put a burden on healthcare agenda in the form of out-of-pocket expenditures in the region (Mendum and Njenga, 2018)., and
iv) The slow pace of sustainable economic activities due to low per capita spending on sustainable healthcare reforms exhausts socio-economic and environmental resources, which needs sustainable policy instruments to progress towards SDGs across Africa (Menegakiand Tugcu, 2016).

The longitudinal data set is used from last 17 years for analyzing the socio, economic and environmental issues in SSA countries, as the selected countries strive hard to combat environmental issues, which is largely influenced country's healthcare agenda and resource depletion that limit to achieve United Nation's Sustainable Development Goals (UNSDGs). Fig. 1 shows the level data plots for ready reference.

The study followed the scholarly work of Ozturk (2017) to develop an environmental interactive model to cover human health cost modeling, environmental sustainability agenda, and conserve natural resource assets in a panel of selected SSA countries. The study used Cobb-Douglas production function that is technological up gradation of the resource inputs to transform in a way to get output through the functional display of 'constant returns to scale'. It is the share of labor and capital in the total output that constant over time, which is fitted by OLS in the production function. It is most widely used indicator of utility function, where the consumer is assumed to have a finite wealth and have certain goods in the commodity basket that they purchased to maximize its utility. This function is widely used in economics discipline where economic output depends upon the factor inputs (i.e., labor and capital) and their total factor productivity, which can be transformed through technology process. This function relates with the theory of production in order to changes in the output determination in a country resources. On the other way around, there is a 'theory of distribution' that explained the division of output determination among the various members of the society. The classical economists theorized about the distribution in the shares among different social classes, i.e., capitals, laborers, and land owners whom involved in certain economic activities and performed under certain economic principles. Thus, the widely accepted Cobb-Douglas production function in this study is used in a schematic style to analyze the resource-income hypothesis under health and particulate emissions damage function, i.e.,

$$Q = F(K, L, R, t) = K^{\alpha 1} L^{\alpha 2} R^{\alpha 3} e^{\lambda t}, \alpha 1 + \alpha 2 + \alpha 3 = 1 \tag{1}$$

where, Q is total production, K is capital stock, L is labor stock, R is natural resource utilization rate, t is time period, λ is assume to constant that represent rate of technological progress, and 'e' is emission intensity, which is associated with technological risk.

Equation (1) is the generalized form of technological augmented Cobb-Douglas production function that is decomposed into health related costs in the form of communicable diseases and high particulate emissions damage, thus, we made a new augmented technological function to include the following factors, i.e.,

$$Q=F(ENV, HLTH, RES, ED)=ENV^{\alpha} HLTH^{\beta} RES^{\gamma} ED^{\eta} \tag{2}$$

Where, Q is aggregate output, ENV shows environment that represent with CO2 emissions, HLTH shows health cost factor represented by communicable diseases, RES shows resource depletion, and ED shows emissions damage.

Thus, the non-linear form of equation (2) is as follows:

$$\ln GDPpc_{it} = \ln A_t + \alpha \ln CO2_{it} + \beta \ln COMD_{it} + \gamma \ln NRD_{it} + \eta \ln PEMD_{it} + \ln \varepsilon_{it} \tag{3}$$

Equation (3) differentiating with 't', then we have the growth rate of the following equation i.e.,

$$\frac{1}{GDPpc_{it}}\frac{dGDPpc_{it}}{dt} = \frac{1}{A}\frac{dA_{it}}{dt} + \alpha\frac{1}{CO2}\frac{dCO2_{it}}{dt} + \beta\frac{1}{COMD}\frac{dCOMD_{it}}{dt} + \gamma\frac{1}{NRD}\frac{dNRD_{it}}{dt} + \eta\frac{1}{PEMD}\frac{dPEMD_{it}}{dt} + \frac{1}{\varepsilon}\frac{d\varepsilon_{it}}{dt} \tag{4}$$

where, 'GDPpc' indicates per capita GDP, 'A' indicates total factor productivity (assume constants), 'CO2' shows carbon dioxide emissions, 'COMD' shows communicable diseases, NRD shows natural resource depletion, PEMD shows particulate emissions damage, 'i' indicates panel of 40 SSA countries, 't' shows time period from 2000 to 2016, and ε indicates error disturbance term.

The study further modeled healthcare cost by simplifying non-linear equation, i.e.,

$$HLTH=F(ENV, Q, RES, ED) = ENV^{\alpha} Q^{\beta} RES^{\gamma} ED^{\eta} \tag{5}$$

Thus, the non-linear form of equation (5) is as follows:

$$\ln COMD_{it} = \ln A_t + \alpha \ln CO2_{it} + \beta \ln GDPpc_{it} + \gamma \ln NRD_{it} + \eta \ln PEMD_{it} + \ln \varepsilon_{it} \tag{6}$$

Equation (6) differentiating with 't', then the growth rate of the following equation i.e.,

$$\frac{1}{COMD_{it}}\frac{dCOMD_{it}}{dt}=\frac{1}{A}\frac{dA_{it}}{dt}+\alpha\frac{1}{CO2}\frac{dCO2_{it}}{dt}+\beta\frac{1}{GDPpc}\frac{dGDPpc_{it}}{dt}+\gamma\frac{1}{NRD}\frac{dNRD_{it}}{dt}+\eta\frac{1}{PEMD}\frac{dPEMD_{it}}{dt}+\frac{1}{\varepsilon}\frac{d\varepsilon_{it}}{dt} \quad (7)$$

Equation (3) further expanded by adding square of natural resource depletion while equation (6) expanded by adding square of per capita income in order to assess the inverted U-shaped relationship between the stated variables. The following equations are as follows:

$$GDPpc_{it}=A_t+\alpha CO2_{it}+\beta COMD_{it}+\gamma NRD_{it}+\delta NRD_{it}^2+\eta PEMD_{it}+\varepsilon_{it} \quad (8)$$

$$COMD_{it}=A_t+\alpha CO2_{it}+\beta GDPpc_{it}+\delta GDPpc_{it}^2+\gamma NRD_{it}+\eta PEMD_{it}+\varepsilon_{it} \quad (9)$$

Equation (8) and Equation (9) differentiating with 't', then we have the growth rate of the following equation i.e.,

$$\frac{1}{GDPpc_{it}}\frac{dGDPpc_{it}}{dt}=\frac{1}{A}\frac{dA_{it}}{dt}+\alpha\frac{1}{CO2}\frac{dCO2_{it}}{dt}+\beta\frac{1}{COMD}\frac{dCOMD_{it}}{dt}+\gamma\frac{1}{NRD}\frac{dNRD_{it}}{dt}+\delta\frac{1}{NRD^2}\frac{dNRD_{it}^2}{dt}+\eta\frac{1}{PEMD}\frac{dPEMD_{it}}{dt}+\frac{1}{\varepsilon}\frac{d\varepsilon_{it}}{dt} \quad (10)$$

$$\frac{1}{COMD_{it}}\frac{dCOMD_{it}}{dt}=\frac{1}{A}\frac{dA_{it}}{dt}+\alpha\frac{1}{CO2}\frac{dCO2_{it}}{dt}+\beta\frac{1}{GDPpc}\frac{dGDPpc_{it}}{dt}+\delta\frac{1}{GDPpc^2}\frac{dGDPpc_{it}^2}{dt}+\gamma\frac{1}{NRD}\frac{dNRD_{it}}{dt}+\eta\frac{1}{PEMD}\frac{dPEMD_{it}}{dt}+\frac{1}{\varepsilon}\frac{d\varepsilon_{it}}{dt} \quad (11)$$

Equation (10) shows that per capita income is explained by high mass carbon emissions, communicable diseases, natural resource depletion, and particulate emission damages in a panel of SSA countries. It is expected that high mass carbon emissions, communicable diseases, natural resource depletion, and particulate emission damages decreases country's economic growth. Similarly, healthcare modeling is assessed by communicable diseases, which is affected by environmental pollutant, per capita income, natural resource depletion, and particulate emission damages. It is expected that carbon emission, natural resource depletion, and particulate emission damages largely affected healthcare cost modeling while per capita income would have an inverted U-shaped relationship with communicable disease.

2.1. Econometric techniques

The first step is to check the stationary properties of the selected variables. For this purpose, we check 'summary' of the unit root tests in panel setting. The results show four different panel unit root estimates, including Levin, Lin, and Chu unit root test (see, Levine et al., 2012), Im, Pesaran, and Shin unit root test (see, Im et al., 2003), ADF and PP unit root tests. All these tests have different significance and power of explanatory abilities at different lag lengths, which work out under different symmetric conditions. The variables that are level stationary confirmed the order of integration is I(0), while the variable is differenced stationary considered as I(1) variable.

The mixture of I(0) and I(1) variables gives a good justification to select the appropriate econometric technique, among which Pooled

Table 1
Descriptive statistics and correlation matrix.

Panel A	CO2	COMD	GDPPC	NRD	PEMD
Mean	0.356	63.112	1507.148	8.161	1.915
Maximum	1.471	78.900	10137.550	55.342	6.994
Minimum	0.036	34.900	193.867	0.000	0.227
Std. Dev.	0.249	8.829	1994.272	8.670	0.976
Skewness	1.987	−0.499	2.562	1.810	1.205
Kurtosis	7.329	3.090	9.025	7.213	5.839
Panel -B: Correlation Matrix					
CO2	1				
	–				
COMD	−0.117	1			
	(0.002)	–			
GDPPC	0.271	−0.199	1		
	(0.000)	(0.000)	–		
NRD	−0.107	0.034	0.074	1	
	(0.005)	(0.371)	(0.053)	–	
PEMD	−0.317	0.232	−0.489	0.034	1
	(0.000)	(0.000)	(0.000)	(0.372)	–

Mean Group (PMG) estimator is one of the right choice to gives short and long-run elasticities between the variables. This technique facilitates to ensure the robustness into the endogeneity among the regressors, to resolve heterogeneity issues and cross-sectional dependence among the selected countries, and worked for dynamic nature of panel data sets. Pesaran and Smith (1995) and after that Pesaran et al. (1999) developed PMG estimator to work out to resolve simultaneity issues from the regressors, interdependence among the cross-sections, and utilization of dynamic model.

Both the short- and long-run causality under the domain of vector error correction model (VECM) further utilized to assess Granger causality by χ^2- test and *t*-test for short- and long-run causality estimates. The causality test is used to find a correlation between the nominal variable and the past values of the other variables, while it does not simply mean that changes occurred in one variable is the cause of changes in the other variable. The following causality results is expected between the studied variables, i.e.,

H1. natural resource depletion and particulate emission damages Granger cause communicable disease and economic growth (one –way causation),

H2. Communicable disease and economic growth Granger cause natural resource depletion and particulate emission damages (reverse causation),

H3. Bidirectional causation among the studied variables (two-way linkages), and

H4. No causation exists among the variables, although it could be highly correlated (neutrality hypothesis).

The VECM has two important functions, first it shows the endogeneity or exogeneity of a variable in the system process, while it shows the direction of Granger causality within the given time period. However, the dynamic process is largely invisible in the VECM, which is captured through impulse response function (IRF) and variance decomposition analysis (VDA) in the post sample period. The IRF is worked under inter-temporal system where regressand in the VAR system affected by the shocks of regressors at different post sample periods. It is evident that some shocks are stable due to stable system of equations, hence it would decline to zero, while if the system of equations are unstable than we find an explosive time path.

The VDA is the alternative system dynamics to analyze innovative accounting shocks that been implied by regressors. This would imply further that in a dynamic system process, i.e., how much of the variance could be generated by forecast error that is explained by innovations to each regressor over a time horizon. The regressand mostly find the own series shocks that explained larger error variance followed by the other regressors in the system. Thus it would determine the least regressors that have innovative shocks applied on the explained factor and lager variance determine by the other regressors in dynamic system. Thus, it would helpful to determine the future error variance in the system dynamics.

Table 2
Summary of panel unit root tests.

Variables	LLC	IPS	ADF	PP	Decision
Level					
CO2	−4.938*	−2.519*	114.857*	153.320*	I(0)
COMD	4.846	9.838	7.914	5.272	I(1)
GDPPC	−0.154	4.150	55.073	45.469	I(1)
NRD	−1.650	−0.131	80.718	88.326	I(1)
PEMD	−12.649*	−3.535*	150.443*	179.650*	I(0)
First Difference					
D(CO2)	−10.248*	−9.443*	234.664*	482.575*	I(1)
D(COMD)	−7.601*	−5.054*	68.536*	181.368*	I(1)
D(GDPPC)	−7.443*	−6.904*	186.122*	308.445*	I(1)
D(NRD)	−14.071*	−10.474*	256.684*	409.657*	I(1)
D(PEMD)	−5.258*	−4.777*	146.254*	279.455*	I(1)

Note:* indicates 1% significance level. 'D' shows first difference.

3. Results and discussions

Table 1 shows the descriptive statistics in Panel A and correlation matrix in panel B for ready reference. The panel A statistics show that carbon emission has a minimum value of 0.036 kg per 2010 US $ and have a maximum value of 1.471 with a mean value of 0.356 kg per 2010 US$. The low percentage of death by communicable disease is about 34.900% and a high percentage of 78.900% with an average percentage of 63.112%. The minimum value of per capita income is US$ 193.867 and maximum value of US$10137.550 with a mean value of US $1507.148. The average value of natural resource depletion and particulate emission damages is about 8.161% of GNI and 1.915% of GNI respectively.

The estimates of Panel -B in Table 1 shows the correlation matrix and found the positive correlation between per capita income and carbon emissions (i.e., $r = 0.271$, $p < 0.000$), which confirmed that economic growth is achieved on the cost of high mass carbon emissions in a panel of SSA countries. The countries should need to care environment by sustainable instruments, including cleaner production technologies (Pusavec et al., 2010), renewable energy sources (Larcher and Tarascon, 2015), tight environmental regulations (Costantini et al., 2017), sustainable production and consumption (Bai et al., 2018), etc. There is a negative correlation between per capita income and communicable diseases ($r = -0.199$, $p < 0.000$), which implies that communicable diseases largely decreases by high per capita income that indicates the positive sign of growth generating activities to spend larger amount on healthcare infrastructure across countries (Wood et al., 2017). The correlation estimates further confirmed that per capita income substantially decreases particulate emission ($r = -0.489$, $p < 0.000$) damages on the cost of natural resource depletion ($r = 0.074$, $p < 0.053$), thus it is viable to preserve our natural assets by environment friendly policies (Goh and Effendi, 2017). Table 2 shows the summary of panel unit root tests for ready reference.

The results show that carbon emission is stationary at level in all four prescribed panel unit root tests, hence the order of integration is zero, i.e., I(0) variable series, similarly, particulate emission damages is level stationary in the given panel unit root tests. The other variables, including communicable disease, per capita income, and natural resource depletion is differenced stationary variables, hence, the order of integration is one, i.e., I(1) variable series. The results confirmed that carbon emissions and particulate emission damages consistently moves over a period of time, while there is a wide fluctuations in the communicable disease pattern, per capita income, and natural resource depletion across SSA countries. Fig. 2 shows the differenced data plots of the respective variables for ready reference.

Table 3 shows the Fisher type panel cointegration test and confirmed the five cointegrating equations, as trace statistics and maximum eigenvalue both fall in less than 5% confidence interval, hence its confirmed the long-run relationship among the studied variables.

After confirmation of the long-run relationship between the candidate variables in the cointegration framework, the study move forward to estimate the optimal lag length. Table 4 shows the lag length criteria to proceed further for obtaining the coefficient estimates by PMG estimator.

The results of lag length selection criteria indicates that optimal lag value is one, as SC criteria shows the significance of the test statistics by the criterion at first lag, thus the coefficient estimates in the PMG estimator is confined up to first lagged variables. Table 5 shows the PMG estimators to obtain short- and long-run parameter estimates. The results confirm the inverted U-shaped relationship between per capita income and natural resource depletion, as first, economic growth increases on the cost of natural resource depletion, while in the subsequent growth stages, the second order coefficient of natural resource depletion

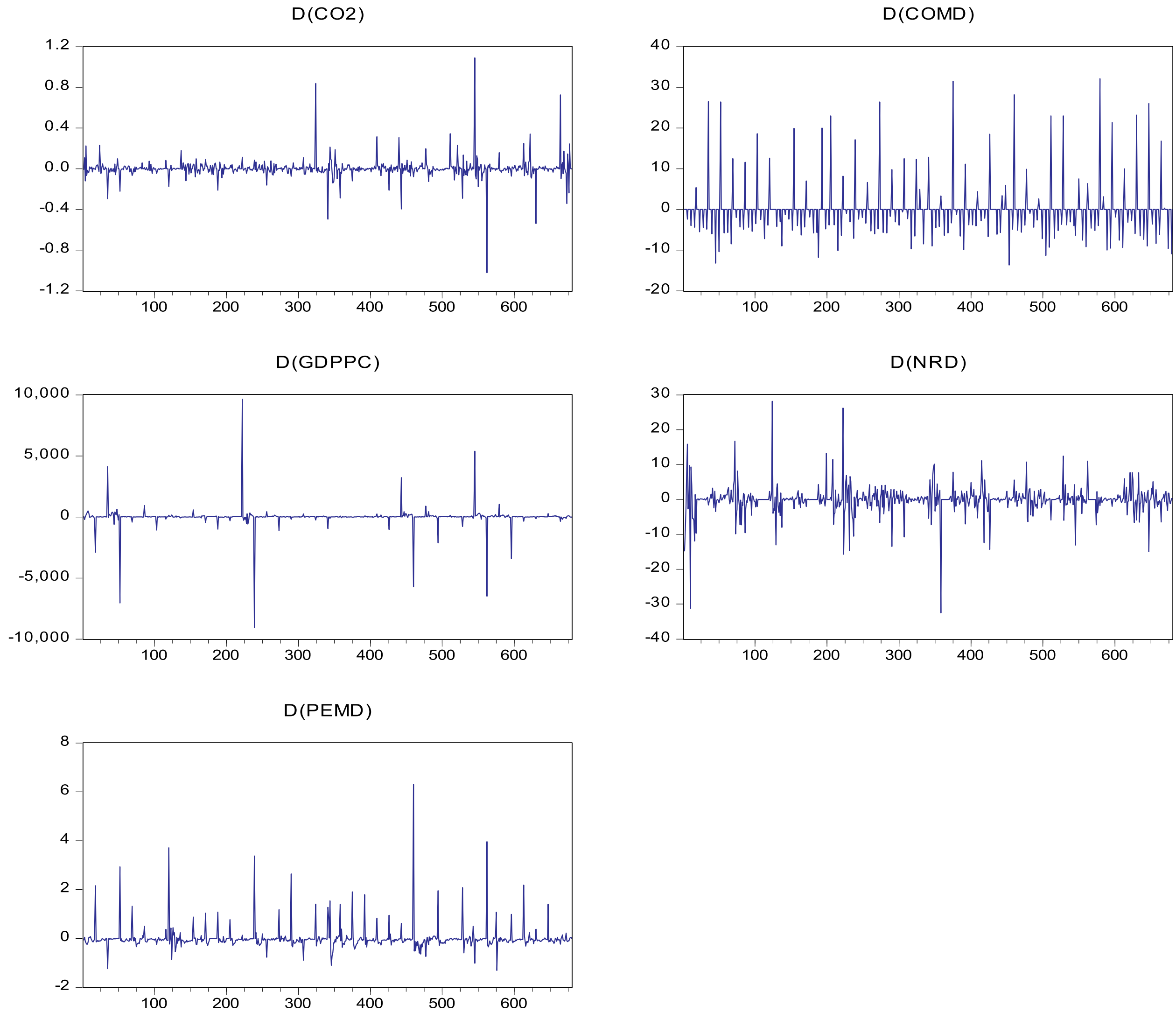

Fig. 2. Plots of differenced Data
Source: World Bank (2017).

Table 3
Johansen Fisher panel cointegration test estimates.

Series: GDPPC CO2 COMD NRD PEMD				
Hypothesized No. of CE(s)	Fisher Stat. (from trace test)	Prob.	Fisher Stat. (from max-eigen test)	Prob.
$r = 1$	379.1	0.0000	379.1	0.0000
$r \leq 1$	1261.	0.0000	970.1	0.0000
$r \leq 2$	525.0	0.0000	399.7	0.0000
$r \leq 3$	235.9	0.0000	191.8	0.0000
$r \leq 4$	167.6	0.0000	167.6	0.0000

becomes negative that shows natural resource depletion, which largely decreases country's per capita income with a turning point of 24.877% of GNI. The different causal channels been explored by the previous studies through which natural resource affects country's economic growth, i.e., high energy demand (Zaman et al., 2017), public investment (Alter et al., 2017), climate justice politics (Bond, 2018), population density and biofuel consumption (Zaman, 2017), average temperature and FDI inflows (Bhuiyan et al., 2018a), carbon-sulfur-GHG emissions (Bhuiyan et al., 2018b), etc. These studies confined that natural resource depletion is linked with the above stated factors that affected country's environmental sustainability agenda across countries.

The results further show that communicable diseases and particulate emission damages both negatively affected country's per capita income in the form of high public spending on healthcare infrastructure and environmental sustainability agenda, while economic activities are insufficient to balance the health and environmental reforms together, thus healthcare burden and environmental reforms both jeopardize the country's economic activities at large. Nugent et al. (2018) discussed the healthcare related sustainable development goals (SDGs) and emphasized the need to reduce non-communicable diseases, which is largely affected the prevention and prospects of healthcare reforms across countries. Wu et al. (2017) discussed three different factors that largely involved in the emergence of high infectious diseases, more particularly, income growth that is found with zoonotic emergence, urbanization that spread the new infections due to greater concentration of people in small arable land, and globalization, which facilitated pathogens to travel from trade and other economic routes among countries. Ginsburg et al. (2017) argued that women largely affected by high infectious diseases, among which breast cancer is largely occurred due to low healthcare investment, vicious cycle of poverty and deprived socio-economic status, including inequalities. This is alarming situation all across countries that considered one of the global challenges for the healthcare professionals to combat with optimized solutions. Misganaw et al. (2017) concluded that prevention and control strategies are required to reduce

Table 4
Lag length selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−6077.255	NA	3.26e+08	33.79030	33.84428	33.81176
1	−3044.717	5963.991	18.03635	17.08176	17.40560*	17.21052*
2	−3005.112	76.78873	16.63207	17.00062	17.59433	17.23669
3	−2977.400	52.96170	16.38655	16.98555	17.84913	17.32893
4	−2949.914	51.76509	16.16778	16.97174	18.10519	17.42242
5	−2905.059	83.22948	14.48793	16.86144	18.26476	17.41943
6	−2833.978	129.9208	11.22549	16.60543	18.27862	17.27072
7	−2791.064	77.24479*	10.17447*	16.50591*	18.44897	17.27851
8	−2772.254	33.33585	10.54739	16.54030	18.75322	17.42020

Note: * indicates lag order selected by the criterion. LR shows sequential modified LR test statistic (each test at 5% level), FPE shows final prediction error, AIC shows Akaike information criterion, SC shows Schwarz information criterion, and HQ shows Hannan-Quinn information criterion.

Table 5
Estimates of pooled mean group (PMG) estimator.

Variables	DV = GDPPC	DV = GDPPC	DV = GDPPC	DV = COMD	DV = COMD
Long-run Coefficients					
NRD	7.870*	17.514*	13.886*	1.448*	0.180*
NRD^2	–	−0.352**	–	–	–
Turning Point of NRD: $\beta_1/2\beta_2$ = 24.877% of GNI					
PEMD	−459.088*	−330.200*	–	47.221*	3.730*
COMD	−8.764*	−14.058*	−7.059*	–	–
CO2	–	–	542.044*	37.855*	−13.524*
GDPPC	–	–	–	−0.0046*	−0.013*
$GDPPC^2$	–	–	–	–	6.87E-07*
Short-run Coefficients					
COINTEG01	−0.107*	−0.051*	−0.064*	−0.102*	−0.383*
D(GDPPC)	–	–	–	−0.011	0.380
D(GDPPC(-1))	0.195*	–	0.040	0.052	–
D($GDPPC^2$)					−0.0001
D(NRD)	26.648	−71.761	3.590	5.086	−0.863
D(NRD(-1))	−8.345	–	−9.103	−3.034	–
D(NRD^2)	–	191.381	–	–	–
D(PEMD)	−171.922***	−307.770*	–	−5.647	−1.176
D(PEMD(-1))	337.972***	–	–	7.099	–
D(COMD)	0.923	0.014	−1.494	–	–
D(COMD(-1))	1.804	–	0.434	–	–
D(CO2)	–	–	−313.782*	−7.855	−0.668
D(CO2(-1))	–	–	−80.970*	25.702**	–
Constant	360.181*	176.748*	−185.534**	−1.835	26.495*
Statistical Tests					
Mean dependent variable	27.434	26.195	27.434	−0.920	−0.862
Standard error of regression	61.166	76.690	69.772	2.216	2.404
Log likelihood	−2226.715	−2667.782	−2430.842	−870.603	−1171.347

Note: *, **, and *** indicates 1%, 5%, and 10% significance level.

Table 6
Granger Causality Results based on VECM.

Dependent	Independent Variables					
	χ^2- statistics of lagged 1st differenced term [p-value]					ECT_{t-1} coefficient
Variable	ΔGDPpc	ΔCOMD	ΔCO2	ΔNRD	ΔPEMD	(t-ratio)
ΔGDPpc	–	0.905 [0.636]	1.134 [0.567]	1.326 [0.515]	0.811 [0.666]	−0.0007 (−0.542)
ΔCOMD	18,645* [0.000]	–	0.011 [0.994]	31.024* [0.000]	20.877* [0.000]	−0.0001* (−4.558)
ΔCO2	0.461 [0.793]	0.451 [0.797]	–	1.236 [0.538]	7.294** [0.026]	6.28E-07 (0.813)
ΔNRD	14.349* [0.000]	49.380* [0.000]	0.389 [0.823]	–	46.591* [0.000]	−0.0006* (−15.020)
ΔPEMD	2.739 [0.254]	10.615* [0.005]	7.452** [0.024]	14.358* [0.000]	–	−1.25E-05* (−5.516)

Note: * and ** denotes significant at 1% and 5% significance level, respectively. The small bracket shows t-statistic and squared bracket shows p-value.

communicable and non-communicable diseases, which is imperative for healthy reforms and improve economic activities across countries.

The results are mixed with carbon emissions, as in the short-run, there is a negative relationship between per capita income and carbon emissions, while in the long-run, it becomes positive. The result implies that higher carbon emissions sabotage the process of environmental sustainability in the short-run, while over a period of time; high industrialization process supports country's economic growth on the cost of environmental destructions, which need sustainable action plans to reduce negative externalities from SSA countries. The previous studies largely discussed the number of sustainable environmental action plans by which SSA countries may get benefited from using it, i.e., promotion of green logistic activities (Aldakhil et al., 2018), eco-tourism/sustainable tourism (Qureshi et al., 2017), biofuel production (Ishika et al., 2017), climate integration policy for optimizing land (Di Gregorio et al., 2017), sustainable energy (Yi et al., 2017),

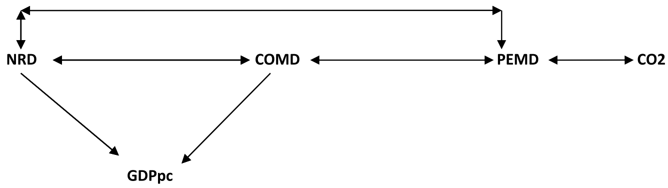

Fig. 3. Summary of Granger Causality
Source: Author's estimation.

Table 7
Estimates of impulse response function.

Response of GDPPC:					
Period	GDPPC	CO2	COMD	NRD	PEMD
1	752.5287	0.000000	0.000000	0.000000	0.000000
2	721.9975	0.001165	1.414760	9.163219	13.61447
3	666.5137	8.764516	12.44974	28.08431	2.435609
4	613.6305	17.56678	21.13896	44.09471	−8.021580
5	563.7321	25.43110	28.90915	56.63104	−15.99543
6	516.8274	32.31889	35.91602	66.28087	−21.83822
7	472.9096	38.27572	42.00846	73.44777	−25.96079
8	431.9403	43.35815	47.09669	78.47687	−28.69732
9	393.8484	47.62493	51.16036	81.68144	−30.32532
10	358.5379	51.13618	54.22744	83.34453	−31.07635

water governance (Robins et al., 2017), natural resource management (McKinley et al., 2017), etc. These studies discussed different sustainable instruments through which SSA countries may conserve its natural resources, environmental stability, and mitigation of carbon-GHG emissions.

The other regression apparatus find a positive relationship between natural resource depletion and communicable diseases, which need to conserve natural resources to improve healthcare cost modeling across countries. The results further reveal that high mass carbon emissions and particulate emission damages both directly linked with the communicable diseases, thus it's a matter of urgency to mitigate carbon-particulate emissions with sustainable environmental instruments in a panel of SSA countries. The result verified the U-shaped relationship between per capita income and communicable diseases, as communicable diseases largely decreases by high economic spending on healthcare reforms at initial level of economic development, while its further increases infectious diseases at the later stages of economic development, as the second order coefficient of per capita income is positive for communicable diseases. Thus, it is evident that across SSA countries, the following are the chief factor that increase communicable diseases, including high mass carbon emissions, particulate emission damages, natural resource depletion and high per capita income, which required carbon mitigating policies, conserve natural resource assets, and sustainable production and consumption for sustainable development. Dora et al. (2015) argued that United Nation Millennium Development Goals (MDGs) were lag behind the target in healthcare sustainability due to low environmental reforms that directly linked with the healthcare morbidity and mortality across the globe. The study conclude that by mitigating carbon emissions and GHG emissions, the global healthcare sustainability could be achieved that helpful to reduce infectious diseases and communicable diseases, which are the forefront challenges faced by the global healthcare professionals. Huang et al. (2014) concluded that global changes in the demographic transition and epidemiologically circumstances led the world into notorious pathogens that certainly affected healthcare sustainability across the globe. The study emphasized the need to adopt WHO best practices in terms of reducing healthcare sustainability issues, including affordable, cost effective and feasible healthcare intervention policies that helpful to promote healthcare sustainability agenda across countries. Sylla et al. (2017) found that road traffic pollution is one of the intensified way of environmental deterioration in the form of higher ambient air pollution that directly linked to the chronic respiratory diseases, which led to increase the risk of asthma and chronic pulmonary diseases across Africa. Yang et al. (2018) emphasized the need to mitigate high mass carbon emissions through integrating national and international sustainable joint efforts, while energy conservation policies further helpful to reduce the global health burden, which is imperative to achieve United Nation's healthcare sustainability agenda across countries. Table 6 shows the short- and long-run Granger causality test based on VECM.

The results confirm the 4th hypothesis (i.e., H4) both in the short- and long-run, as GDP per capita has no such causal relationship among communicable diseases, carbon emissions, natural resource depletion, and particulate emission damages, although it is highly correlated with the stated factors. Communicable disease Granger cause per capita income, which supported 2nd hypothesis (i.e., H2), while natural resource depletion Granger cause per capita income to support 1st hypothesis (i.e., H1). The feedback relationship is found between i) natural resource depletion and communicable diseases, ii) communicable disease and particulate emission damages, iii) natural resource depletion and particulate emissions damages, and iv) particulate emission damages and carbon emission to support 3rd hypothesis (i.e., H3). The long-run causality is established among the following model, i.e., communicable disease, natural resource depletion, and particulate emission damages. Fig. 3 shows the summary of causal relationships between the variables for ready reference.

Table 7 shows the estimates of IRF and confirmed that carbon emissions positively shock to per capita income on the cost of high infectious disease and natural resource depletion that put a burden on global healthcare agenda and natural resource assets, over a time horizon. The country's per capita income will largely be influenced by high particulate emission damages, as it have a negative shock to the country's economic activities for the next 10 years time period.

The economic rationale of IRF estimates is largely visible due to poor healthcare infrastructure and low adaptability of environmental sustainability reforms in a panel of selected SSA countries. The high mass carbon emissions are takeover through unsustainable production and consumption, which not only damages the natural environment, while it influenced country's healthcare sustainability agenda in the form of communicable and non-communicable diseases (Cairncross et al., 2018). Further natural resource depletion due to unsustainable economic transformation promote the 'resource curse' hypothesis, which sabotage the United Nation sustainable development goals that flair with particulate emission damages and carbon emissions. It is imperative to mitigate carbon emissions and particulate emission damages through rigid environmental policies (DeCaro et al., 2017), environmental certification (Lee et al., 2017), embodied carbon tariffs (Böhringer et al., 2018), utilization of cleaner production techniques (Severo et al., 2017), renewable energy sources (Rahman et al., 2017), and sustainable production and consumption (Sala et al., 2017). Global healthcare agenda is optimized through healthcare spending - both private and public partnership programmes would be beneficial (Visconti et al., 2017), healthcare insurance (Habibie et al., 2017), health awareness media campaigns (Nelson and Namitra, 2017), sustainable sanitary and water resource programmes (Farnleitner et al., 2018), healthy diets (Perignon et al., 2017), and preventive healthcare medicines (Kaplan and Forst, 2017). These options would serve as a better solution to control communicable and non-communicable diseases. Fig. 4 shows the IRF estimates for ready reference.

Table 8 shows that forecast variance error estimates that largely visible by its own shocks of per capita income, afterward, natural resource depletion will exert a larger variance error, followed by communicable disease, carbon emissions, and particulate emission damages, over a next 10 years time period.

The results show that 100% forecast error variance found by GDP per capita of its own shocks, while the contribution of CO2, COMD, NRD,

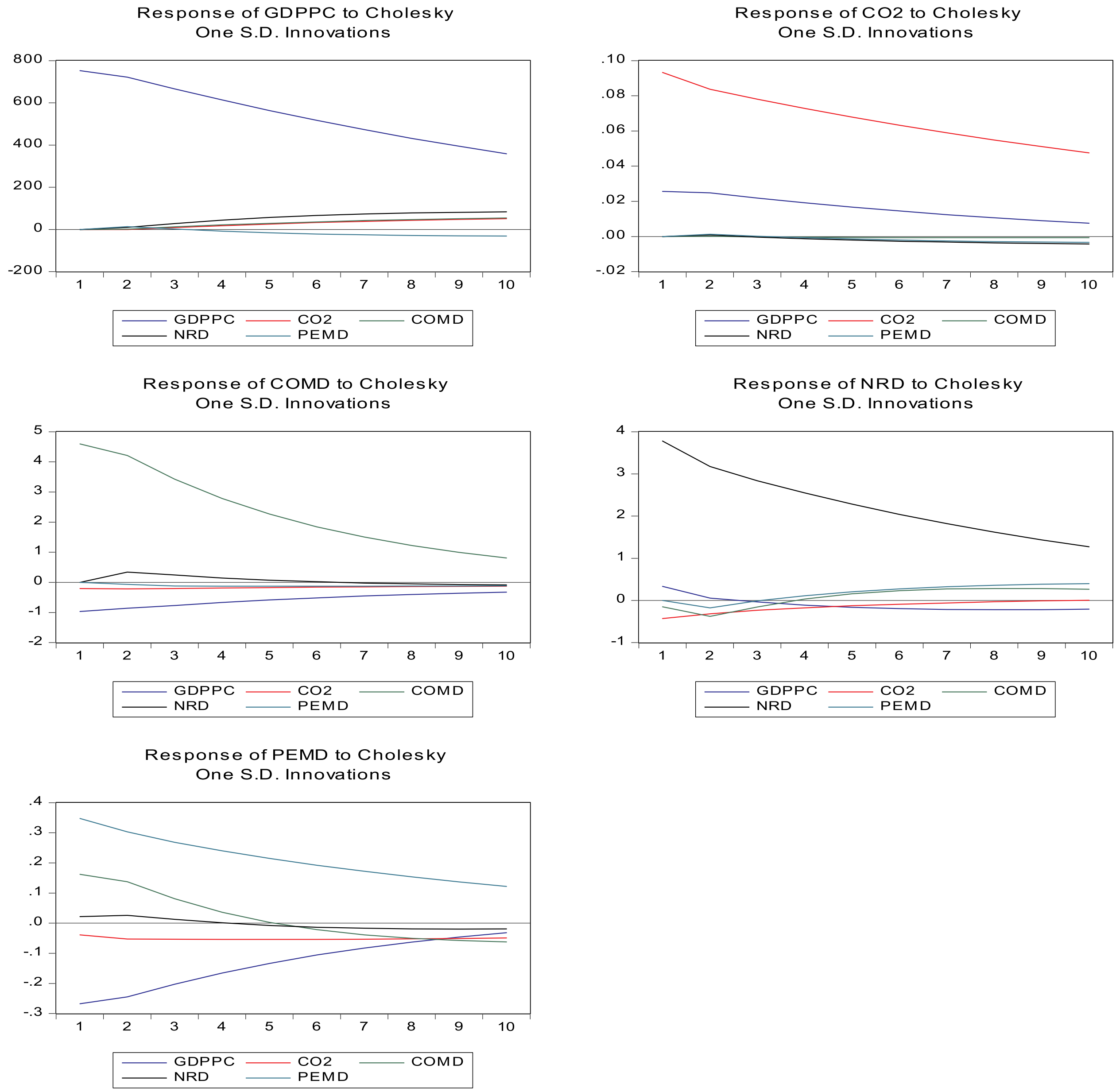

Fig. 4. IRF estimates.

Table 8
Variance decomposition analysis.

Variance Decomposition of GDPPC:						
Period	S.E.	GDPPC	CO2	COMD	NRD	PEMD
1	752.528	100	0	0	0	0
2	1,043.001	99.975	1.25E-10	0.0001	0.007	0.017
3	1,238.191	99.915	0.005	0.010	0.056	0.012
4	1,382.904	99.787	0.020	0.031	0.147	0.013
5	1,495.046	99.597	0.046	0.064	0.269	0.022
6	1,584.133	99.353	0.082	0.108	0.415	0.039
7	1,656.026	99.069	0.129	0.163	0.576	0.060
8	1,714.664	98.755	0.184	0.228	0.747	0.084
9	1,762.858	98.421	0.247	0.300	0.921	0.109
10	1,802.688	98.075	0.317	0.377	1.095	0.134

and PEMD will be strongly exogenous in the short-run, which implies that all the variables will have a very weak influence with the per capita income in future. In the long-run, about the last 10th forecasted period, it implies that the contribution of the stated factors will have a strong endogenous influence on per capita income, which will gradually improves our the time horizon. The economic rationale is obvious due to large drain of natural resources due to low sustainable reforms, which need to be balanced by mitigating carbon emissions policies across countries.

The implications of the results are in line with the developing countries context, which needs sustainable environmental reforms to mitigate high mass carbon emissions and particulate emissions to prevent country's healthcare sustainability agenda. The following viewpoints would be important that not limited for the African countries, while it is important for the developing countries, i.e., water resource management, improved agricultural value added, limit deforestation, population control, poverty reduction, urban development, sustainable production and consumption, and healthcare reforms should be high priority of the developing countries including Africa to conserve natural environment and health related morbidities and mortalities for sustainable healthcare development. Further, the transparency in accountability, progress towards achieving energy efficiency, good governance reforms, political justice, and freedom of voice may expedite the process of sustainable development reforms across countries. Finally, the importance in the formation of natural disaster mitigation centre, participation in local community development, emphasize for trade instead foreign aid, collaborative international efforts and local community's interaction, conservation of biodiversity and ecosystem, and land management are further optimized solution for achieving sustainable development. The healthcare agenda should be on priority list, which would be possible to reduce by particulate emission damages, healthcare subsidize infrastructure, and achieving global sustainable healthcare policies.

4. Conclusions

The objective of the study is to examine the dynamic linkages among communicable disease, natural resource depletion, carbon emissions, particulate emissions, and per capita income in a panel of 40 SSA countries, covered a 17 years panel data set from 2000 to 2016. The study employed panel cointegration test, Granger causality, impulse response function, and variance decomposition analysis for robust inferences. The results confirmed the long-run and cointegrated relationship among the studied variables. The results show that economic growth increases on the cost of natural resource depletion at initial level, however, it substantially inverted when natural resource depletion surpass the value of 24.877% of GNI, which decreases per capita income at later stage. On the other way around, country's per capita income substantially decreases communicable disease at initial level, however, it becomes U-shaped when per capita income continuously grow at the expense of infectious disease. The results reveal that country's per capita income largely decreases due to high particulate emission damages and undeniable health losses due to infectious diseases, while high scale carbon emission tend to show a positive impact on country's economic growth, which sabotage the process of environmental sustainability across SSA countries. The results evident that unsustainable air quality largely damage the country's healthcare reform, which is the forefront challenges that faced the globe by high burden of infectious diseases.

The results of Granger causality confirmed the bidirectional causality between natural resource depletion and particulate emissions damages on one hand, while on other hand, natural resource depletion and communicable disease moves with each other in the same direction over a period of time. Communicable disease Granger cause particulate emission damages and vice versa, while particulate emission damages and carbon emissions both simultaneously moves with each other in a same direction both in the short- and long-run. The one –way causality running from natural resource depletion to per capita income and from communicable disease to per capita income across countries. The results of IRF shows that except particulate emission damages, the other stated factors, i.e., high scale carbon emissions, communicable disease, and natural resource depletion will positively influence country's per capita income, which comes to the conclusion that United Nation's SDGs will largely influenced in the form of environmental destruction, unsustainable healthcare burden, and resource depletion over a time horizon, while particulate emission damages will decrease economic activities for the next 10 years time period. The VDA estimates confirmed that in the short-run, per capita income itself have a greater innovative shocks while the remaining factors are strongly exogenous, while in the long-run, the stated factors becomes strongly endogenous, among which natural resource depletion exert a larger forecast variance error while particulate emission damages exert a least forecast variance error over a time horizon.

On the basis of significant results, the study proposed the following policy implications to conserve natural environment and sustainable healthcare agenda in a panel of SSA countries, i.e.,

- Climate change largely influenced healthcare sustainability agenda through different infectious diseases, while it is imperative to mitigate anthropogenic pollutants through improved healthcare infrastructure, medicated solutions, sustainable water and sanitary resource treatment, health insurance, public-private health associated programmes, and media campaigns, all the resources would benefit to sustained healthcare infrastructure that further limit carbon emissions across countries.
- Comparative cost benefit analysis is imperative for economic development and sustainable environment through improved investment in energy efficiency infrastructure, water-energy-food resources, and climate change mitigation strategies that offset the short-run externality comparison with the long-run benefits.
- Skill development programmes, gender equality, social justice, and tight environmental regulations, all may lead towards sustainable development, thus these factors important across African countries for broad-based growth.
- Healthcare morbidities and mortality is largely penetrated across African countries, which need substantial reforms to reduce preventable complications in child birth and/or during pregnancy that leads to increase the risk of maternal mortality while due to malnutrition, poor sanitation, deficiency of basic nutrients, malaria and pneumonia are commonly found that lead to high risk of under −5 mortality ratio. HIV/AIDS, tuberculosis, water borne disease, and many more infectious disease led towards mortality, which is common across Africa that need supplementary policy medicine to cover with healthcare taxation policies, public-private healthcare partnership for infrastructure development, national and international collaboration to fight against hunger and poverty, availability of preventive medicine, social awareness, healthy diet, etc., all factors lead to progress towards healthy Africa.
- The adaptation of climate change policy and mitigation of carbon-fossil-GHG emissions is imperative to reduce healthcare burden that could be achieved through cleaner production techniques, carbon free policies, renewable energy sources, tight environmental regulations, sustainable production and consumption, ISO certification, environmental taxation, healthcare investment, and social awareness campaigns.

The policies are many, however, the implementation with sustainable instruments is the real challenge to the African policy makers in order to reduce undeniable health losses by infectious and non-communicable diseases and conserve natural environment in order to achieve the target of United Nation's SDGs for 2030 in order to transform better Africa. It is shared responsibility to all global players to assist Africa with accelerating response to health initiatives, socio-economic development, environmental conservation, and building sustainable institutions that have a carrying capacity to lead Africa towards global prosperity.

Acknowledgments

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Appendix

Table A
List of Sample Countries.

Angola	Djibouti	Liberia	Senegal
Benin	Eritrea	Madagascar	Sierra Leone
Botswana	Ethiopia	Malawi	South Africa
Burkina Faso	Gabon	Mali	Sudan
Burundi	Gambia, The	Mauritania	Swaziland
Cameroon	Ghana	Mozambique	Tanzania
Central African Republic	Guinea	Namibia	Togo
Chad	Guinea-Bissau	Niger	Uganda
Comoros	Kenya	Nigeria	Zambia
Cote d'Ivoire	Lesotho	Rwanda	Zimbabwe

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