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# Exploring the impacts of institutional quality, urbanization, and disaggregate globalization on environmental pollution in Somalia

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**ABSTRACT**

Environmental pollution and its implications are widespread issues that require a comprehensive understanding of effective strategies to mitigate emissions. Given the unique challenges faced by Somalia, including social, political, and environmental factors, it is crucial to assess the effects of social and political globalization, urbanization, and institutional quality on greenhouse gas (GHG) emissions. Therefore, this study aims to examine the relationship between these variables and environmental deterioration in Somalia. The study employs the autoregressive distributed lag (ARDL) bound test, the fully modified ordinary least squares (FMOLS) method, and causality tests. The empirical results of the bound test indicated that institutional quality and social-globalization enhance environmental quality by reducing environmental pollution in Somalia in the long run. On the contrary, economic growth impedes environmental quality in Somalia in the long run. However, political globalization and urbanization are inconsequential in the long run. To obtain reliable results, we conduct a robust analysis using the fully modified ordinary least squares (FMOLS) method. And the results of the study are robust for the various methods used. Based on the empirical evidence, the study offers several policy implications.

**IMPACT STATEMENT**

This study aims to examine the impact of disaggregate globalization, institutional quality, and urbanization on environmental deterioration in Somalia. The study utilizes the autoregressive distributed lag (ARDL) bound test, fully modified ordinary least squares (FMOLS) method, and causality tests. The empirical results of the bound test indicate that institutional quality and social globalization improve environmental quality by reducing environmental pollution in Somalia in the long run. On the contrary, economic growth impedes environmental quality in Somalia in the long run. However, the remaining explanatory variables are inconsequential in the long run. Based on the empirical evidence, the study offers several policy implications.

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## 1. Introduction

The linkage between globalization, institutional quality, and environmental sustainability has emerged as a pivotal theme in contemporary ecological discourse. Greenhouse gas (GHG) emissions have increased since the onset of the industrial age, leading to an upsurge in radiative forcing on the climate, which tends to warm the surface and cause climatic changes (Abdi, 2023; Canadell et al., 2021; Warsame & Daror, 2024). At the heart of this dialogue is the recognition of how social and political globalization, through the transnational flow of ideas, cultural values, and political ideologies, can reshape environmental governance across the globe (Dauvergne, 2013). While social globalization facilitates the diffusion of environmental consciousness and green technologies, political globalization often promotes the proliferation of international treaties and collaborative governance frameworks (Jahanger et al., 2023). The

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effectiveness of these processes is supported by the quality of institutional frameworks, which are crucial for converting international agreements into concrete environmental results (Bekun et al., 2021). Robust institutions are identified as a cornerstone for effective environmental policy-making and for the enforcement of measures aimed at reducing GHG emissions (Uzar, 2020; Warsame et al., 2022). Thus, it is remarkable to identify the interaction between globalization, institutional quality, and GHG emissions in developing countries to implement effective environmental policies that mitigate their ecological footprints.

Empirical studies suggest that globalization has a variety of effects on the environment, depending on the channel *via* which it enters. The globalization process has an impact on environmental quality as it alters variables including energy, employment, technology, foreign direct investment (FDI), economic growth, and industrialization (Hussein, Warsame, Ahmed, & Salad, 2024; Pata & Caglar, 2021). It is widely agreed that the process of globalization has effectively reduced the income gap between emerging and developed nations through investments in capital and technology (Jahanger et al., 2022b). However, this has come at the expense of environmental deterioration. Ample studies claim that the process of globalization has a detrimental effect since it amplifies the total pollution level *via* the heightened breakdown resulting from increased $CO_2$ emissions (Chien et al., 2021; Suki et al., 2020; Warsame et al., 2024). $CO_2$ emissions resulting from globalization are identified as a primary factor contributing to deforestation, natural resource depletion, climate change, and global warming (Khan et al., 2022a) During the process of globalization, the industrial sector engages in the production of goods to cater to international demand, resulting in heightened consumption of resources and the emission of pollutants into the (Yilanci & Pata, 2020). Increased engagement in production and consumption activities has the potential to directly contribute to the escalation of environmental deterioration (Pata & Caglar, 2021).

Globalization has profoundly affected environmental degradation in Somalia by raising demand on the nation's already vulnerable ecosystems. With the expansion of foreign investments and trade frequently fueled by worldwide market requires, natural resources like forests and water are being excessively exploited. The processes of urbanization and increased trade have resulted in heightened pollution and deforestation, while the nation's susceptibility to climate change is exacerbated by global economic and environmental transformations (Warsame, Abdi, et al., 2023) Although globalization fosters economic growth and technological developments, it frequently leads to unsustainable behaviors detrimental to Somalia's environment, requiring an effort of a balance between progress and environmental sustainability.

The significance of globalization lies in its facilitation of technological transfer and collaboration across nations to address the issue of climate change (Ansari et al., 2021). Since the use of non-renewable energy sources is closely linked to the pace of economic expansion, the increasing global demand for goods and services has led to a rise in energy consumption (Abdi, 2023; Khan et al., 2022b). Notably, environmental regulations in developing countries often attract pollution-intensive industries from advanced nations, leading to environmental deterioration in the receiving regions (Shahbaz et al., 2015; Wenlong et al., 2023). This phenomenon contributes to emissions, where shifts in production locations due to varying environmental standards result in the redistribution of emissions from one country to another. On the contrary, globalization encourages knowledge transfer to developing nations and the adoption of cleaner production methods, which positively impacts the environment. International relationships between multinational corporations and countries have aided in the diffusion of technological advances into emerging economies, aiding in some manner in ecosystem preservation (Adebayo et al., 2022). The spread of expertise and eco-friendly technology not only enhances environmental quality but also improves labor efficiency and capital productivity, streamlining manufacturing and reducing emissions (Jun et al., 2021; Mansoor & Tahir, 2021).

One of the major obstacles to the goal of reducing greenhouse gas (GHG) emissions is the complex impact of urbanization. In developing countries, settlement patterns are rapidly changing, with more people moving to cities as the economic gap between urban and rural areas widens (Wu et al., 2016). Wang et al. (2016) noted that a large part of the workforce is shifting from agriculture to urban-based industries, driven by the rapid pace of economic globalization and social development. As cities grow, their populations become essential to the industrialization process and mass production systems (Ansari

et al., 2021). However, this growth leads to increased energy use and transportation, causing negative side effects, such as energy waste and pollution (Tahir et al., 2021).

In Somalia, urbanization has surged significantly over the past 30 years. By 2021, 47% of the population lived in urban areas, marking a 32.5% increase since 1991, compared to only a 16% rise between 1970 and 1991 (Warsame, Abdi, et al., 2023). The rapid urbanization in Somalia is intensifying environmental concerns, as increased energy consumption, transportation, and waste generation contribute to pollution and resource depletion, highlighting the urgent need for sustainable urban planning and environmental policies.

Conversely, numerous studies have extensively investigated the impact of institutional strength as a determining factor in improving environmental quality. Environmental issues in developing nations often correlate with weak institutional frameworks, especially in the political realm, leading to ineffective enforcement of environmental laws (Khan et al., 2022b).

Somalia's environmental issues are exacerbated compared to other Sub-Saharan African countries due to persistent political instability, ineffective governance, and protracted conflict (Hussein, Warsame, Ahmed, & Abdullahi, 2024). Many developing nations have challenges, such as deforestation and pollution; however, Somalia contends with inadequate enforcement of environmental regulations, restricted institutional capability, and an absence of long-term strategic planning (Abdi et al., 2025). The lack of a stable administration has hindered the resolution of environmental issues, in contrast to other African states that have established governance and environmental initiatives. Somalia's environmental issues, including droughts, desertification, and soil erosion, are exacerbated by a significant reliance on foreign aid and the susceptibility of populations to climate change, complicating the pursuit of sustainable solutions (Warsame, Sheik-Ali, et al., 2023).

Previous studies have thoroughly investigated the role of institutional factors, such as governance effectiveness, democracy, legal systems, political stability, and regulatory quality in impacting environmental challenges, particularly in terms of emissions (Warsame et al., 2022; Wenlong et al., 2023). It has been demonstrated that robust institutions can avert market inefficiencies, create impactful regulations, and formulate effective environmental strategies, all of which contribute positively to environmental health (Wenlong et al., 2023). On the flip side, subpar institutional quality often results in inefficient resource management and environmental deterioration (Jahanger et al., 2022a). Overall, the effectiveness of institutions is crucial to environmental outcomes, highlighting the necessity for robust legislative and institutional mechanisms to reduce environmental harm and foster sustainable global practices (Azam et al., 2021). Several researchers have suggested that strong institutional structures can suppress environmental degradation (Cao et al., 2022; Sheraz et al., 2022). However, some evidences revealed that institutional quality increases environmental deterioration (Islam, 2021; Kamran et al., 2019). Regarding this, the literature on the institutional quality-environment nexus remains inconclusive, which necessitates further investigation, particularly in countries with deficient government institutions, such as Somalia.

Research on industrialized nations has dominated global inquiries into elevated atmospheric carbon effects, but recent concerns have expanded the focus to include developing economies as well (Abdi, 2023). Amidst the continuing discourse on the effects of globalization and institutional quality on environmental degradation, the current study examines the connection between quality institutions, social and political globalization, urbanization, and GHG emissions in Somalia by using time-series data from 1990 to 2018. To the best of the authors' knowledge, no previous effort has analyzed the connection between these variables within a single framework in the context of Somalia. Hence, this study contributes to the literature as follows. The few prior studies on the subject in the context of Somalia have used an aggregated variable of globalization, which does not capture the actual effects of globalization on the environment, as the various components of globalization affect environmental quality differently (Warsame, Abdi, et al., 2023). Additionally, the study utilizes advanced estimation methods, including the ARDL bound test, FMOLS, and Granger causality tests. These techniques are applied to derive more thorough policy suggestions based on the linkage between globalization, institutional quality, and GHG emissions in the context of Somalia.

The structure of this paper is outlined as follows. Section 2 represents a review of the literature. Section 3 delineates the econometric methods employed and the data sources utilized. The findings and discussions are presented in Section 4, while the concluding section offers a summary and outlines the pertinent policy implications.

## 2. Literature review

### 2.1. Globalization and environmental pollution

The dimensions of globalization (economic, political, and social), economic growth, and institutional quality are key factors that have a significant influence on environmental degradation. Globalization refers to the rising economic connectedness between nations, encompassing the facilitation of free trade, the exchange of information, international capital movements, and the expanding mobility of labor (Fischer, 2003). Considering its relation to industrialization and urban growth, this process has global environmental concerns (Van Veen-Groot & Nijkamp, 1999). Ample studies support the Pollution Haven Hypothesis (PHH), indicating that globalization pushes companies to transfer pollution-intensive businesses to nations with lenient environmental rules (Baek & Kim, 2013; Le & Ozturk, 2020). However, proponents of the Environmental Kuznets Curve (EKC) suggest that globalization initially exacerbates environmental degradation but then ameliorates it through income growth and technological transfer (Nathaniel & Khan, 2020; Usman et al., 2020).

Globalization is categorized into three primary dimensions: social, economic, and political globalization. These dimensions are quantified and represented as an index developed by the KOF Swiss Economic Institute (Dreher, 2006).

Similarly, according to Dreher (2006), globalization describes the process of creating networks of connections among actors at intra- or multi-continental distances, mediated through a variety of flows including people, information and ideas, capital, and goods. Economic globalization encompasses the movement of capital and services, the long-distance transportation of goods, as well as the exchange of ideas and information that accompanies market transactions. Social globalization refers to the dissemination of information, ideas, and images. Political globalization refers to the spread of institutional policies.

Hence, the relationship between globalization and the environment has resulted in escalating levels of apprehension. Gaining a comprehensive understanding of this enduring link is crucial for decision-makers committed to achieving sustainable development. To advance such development, it is imperative to consider environmental, social, and economic issues. Although the link between globalization and the environment has garnered significant attention in recent years, much of the empirical literature remains limited in scope (Kihombo et al., 2021).

Several studies in the current literature have examined generic aspects without delving into the particular channels and causal relationships between the two variables. For instance, several studies emphasized the impact of the economic components of globalization, particularly those relating to trade. Most of these studies have identified that economic globalization enhances environmental quality in developing countries (Kihombo et al., 2021; Sasana et al., 2018). In detail, Kihombo et al. (2021) assessed the effect of financial globalization on the environmental quality measured by ecological footprint in West and Middle East countries from 1990 to 2017. They reported that financial globalization reduces the ecological footprint. Similarly, Ahmed et al. (2021) explored the effect of economic globalization on the ecological footprint in Japan for the period from 1971 to 2016. The empirical results uncovered that economic globalization enhances ecological sustainability in Japan.

On the other hand, ample studies confirmed the adverse effects of economic globalization on environmental quality (Ahmed et al., 2021; Destek, 2020; Yilanci, 2020). Moreover, Yurtkuran (2021) examined the effects of economic globalization on $CO_2$ emissions in Turkey using the bootstrap ARDL approach between 1970 and 2017. The empirical results highlighted that economic globalization has detrimental effects on Turkey's environmental quality. Destek (2020) examined different dimensions of globalization on environmental pollution in Central and Eastern European countries from 1995 to 2015. It was observed that economic globalization raises environmental degradation.

Social globalization refers to the sharing of ideas and information between and through different countries, as well as the cross-border movement of cultures and openness of media. Social globalization can have a positive or negative effect on the environment. The internet and social media encourage people to consume more, which can be a problem for the environment (Bu et al., 2016). Moreover, the irrational development of the internet and the massive use of related devices lead to an increase in power consumption, which may negatively impact the environment (Kihombo et al., 2021). Salahuddin et al. (2016) concluded that internet usage is harmful to environmental quality. On the other hand, social

globalization enhances environmental quality through international social integration, which might generate more environmental technology spillovers that lead to better environmental quality (Jahanger et al., 2022a; Mehmood, 2021).

Political globalization measures the degree of the country's international political engagement (Heshmati, 2006). The nexus between political globalization and environmental quality indicated blended results. Some studies reported that political globalization hinders environmental quality (Mehmood, 2021; Sasana et al., 2018; Shahbaz et al., 2015). While other studies stated that political globalization promotes environmental quality (Akif, 2021; Lenz & Fajdetić, 2021).

### 2.2. Institutional quality and environmental pollution

The connection between institutional quality and environmental pollution has gained substantial attention in the realm of sustainability and development. As environmental challenges, such as climate change, pollution, and habitat loss, continue to escalate, understanding how quality institutions influence environmental outcomes has become crucial (Ahmad et al., 2023). Institutional quality encompasses the effectiveness, transparency, accountability, and governance practices of institutions within a country (Amin et al., 2023). Moreover, institutional quality implies the set of norms that govern relationships in social, political, and economic conditions that indicate human behavior (Hussain et al., 2022). Effective institutions can shape environmental quality through regulation, policy formulation, and the enforcement of environmental standards. Weak institutions, on the other hand, may hinder efforts to protect the environment. This literature review examines the existing research on the relationship between institutional quality and $CO_2$ emissions to better understand how institutional factors shape environmental outcomes.

One fundamental aspect of institutional quality is the ability of governments to enact and enforce environmental regulations. Ample studies reported that institutional quality enhances environmental quality in emerging countries (Ahmed et al., 2021), in African nations (Kwakwa, 2023), in a sample of panel developing countries (Jahanger et al., 2022b), in Pakistan (Ahmed et al., 2020), and in Asia-Pacific Economic Cooperation (APEC) countries (Danish & Ulucak, 2020). In the same vein, Islam et al. (2021) assessed the impact of institutional quality on $CO_2$ emissions in Bangladesh over the period 1972–2016 by utilizing the ARDL technique. They found that institutional quality raises environmental quality. Moreover, Warsame et al. (2022) investigated the effect of institutional quality on environmental degradation in Somalia using data spanning 1990–2017. The empirical result indicated that institutional quality enhances environmental quality. Hussain and Dogan (2021) investigated the nexus between institutional quality and environmental degradation in BRICS nations by employing data from 1992 to 2016. They reported that institutional quality reduces environmental degradation.

Conversely, numerous studies have shown that environmental quality is hampered by institutional quality (Khan et al., 2022b; Wu, 2017). Amin et al. (2023) stated that institutional quality contributes to environmental degradation in South Asian countries. Azam et al. (2021) assessed the effect of institutional quality on environmental degradation in 66 developing countries using the Generalized Method of Moments (GMM) for the period 1991–2017. The empirical findings on the institutional quality-environmental pollution nexus produced inconsistent results because of the various environmental quality measures.

### 2.3. Urbanization and environmental pollution

Urbanization has become an essential global trend that has changed the globe's environment and has had enormous impacts on social, economic, and environmental conditions. The effects of urbanization on environmental quality have become a major issue as more people shift to urban areas. The impacts of urbanization on environmental quality revealed conflicting conclusions because of the differences in economic prosperity between the countries. Studies concentrated on developing nations found that urbanization degrades environmental quality (Ansari et al., 2021; Hassan et al., 2019; Rahman & Vu, 2020). Doğan et al. (2019) revealed that the rate of urbanization undermines the environmental quality in lower- and higher-income countries. Similarly, Islam (2021) reported that urbanization raises $CO_2$ in Bangladesh. A recent study by Abdi (2023) found that urbanization contributes to the deterioration of environmental quality in 41 nations in Sub-Saharan Africa. Conversely, Danish and Ulucak (2020) explored the role of urbanization on

environmental quality in BRICS for the period 1992–2016. They revealed that urbanization improves environmental quality. Similarly, Gasimli et al. (2019) assessed the nexus between urbanization and environmental degradation in Sri Lanka. They demonstrated that urbanization decreases carbon emissions.

## 3. Materials and methods

### 3.1. Data sources and descriptions

The current study investigates the impact of social and political globalization, urbanization, and institutional quality on GHG emissions in Somalia using balanced secondary data from 1990 to 2018. The sample period is determined by the availability of the data. The World Bank, KOF, and SESRIC are the sources of the data. Among the factors sampled for the study are environmental degradation measured by GHG emissions, globalization dimensions, institutional quality, and economic growth. Natural logarithm transformations were employed in the study to mitigate the issues of heteroskedasticity. By transforming variables using the natural logarithm, we stabilize variance across observations, ensuring more reliable and consistent regression estimates. Economic growth and urbanization are hypothesized to have a significant contribution to the rise in environmental degradation. According to Warsame, Abdi, et al. (2023) indicate that economic growth raises environmental pollution. Thus, to account for these effects on environmental degradation, economic growth is utilized as a control variable. The data and its sources are shown in Table 1, and the trends of the sampled variables are presented in Figure 1.

**Table 1.** Data sources and description.

| Variable | Code | Description | Source |
|---|---|---|---|
| Environmental degradation | GHG | Greenhouse gas emissions (Mt $CO_2$) | World Bank |
| Real gross domestic product | RGDP | Real gross domestic product (constant 2010) | SESRIC |
| Urbanization | UR | Percent of urban population to the total population | World Bank |
| Institutional quality | IQ | Combination of political and civil rights. | Freedom House |
| Globalization | GL | KOF globalization index | KOF |

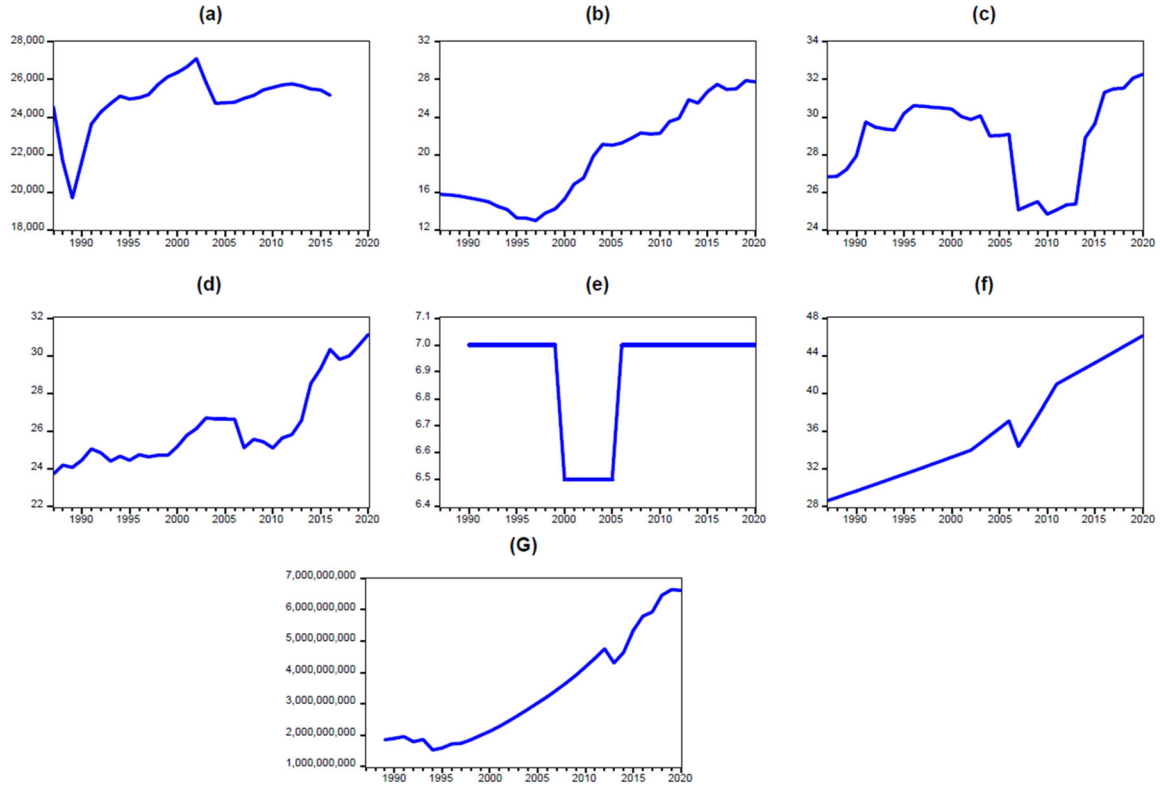


**Figure 1.** Trend of variables: (a) GHG. (b) SOGL. (c) POGL. (d) GLO. (e) IQ. (f) URB. (g) RGDP.

### 3.2. Econometric methodology

To achieve the objective of the study, the ARDL approach is utilized. The ARDL approach performs better than other cointegration techniques in many aspects. Firstly, small sample sizes may be employed with the ARDL, as it does not require long time-series data. Secondly, the ARDL has the flexibility of regressing whether the variable is stationary at level I (0), first difference I (1), or the combination of both. Thirdly, unlike other methods. The variables' long- and short-term cointegrations are simultaneously regressed (Pesaran et al., 2001). Following the previous undertakings of Usman et al. (2021) and Warsame, Abdi, et al. (2023), we specify the model specification of the study as follows:

$$lnGHG_t = \beta_0 + \beta_1 lnSOCGL_t + \beta_2 lnPOGL_t + \beta_3 lnGLO_t + \beta_4 lnIQ_t + \beta_5 lnURB_t + \beta_6 lnRGDP_t + \varepsilon_t \quad (1)$$

$lnGHG_t$ is the log of greenhouse gas emissions in year $t$, $lnSOCGL_t$ is log of social globalization in year $t$, $lnPOGL_t$ is the log of political globalization in year $t$, $lnGL_t$ is log of globalization in year $t$, $lnIQ_t$ is the log of institutional quality, $lnURB_t$ is the log of urbanization, $lnRGDP_t$ is the log of real gross domestic product, and $\mathcal{E}_t$ is the disturbance term in time $t$. Model 2 utilizes the ARDL cointegration approach, which is similar and denoted by:

$$\begin{aligned}\Delta lnGHG_t = {} & +\alpha_0 + \sum_{i=0}^{p} \Delta\alpha_1 lnGHG_{t-k} + \sum_{i=0}^{p} \Delta\alpha_2 lnSOGL_{t-k} + \sum_{i=0}^{p} \Delta\alpha_3 lnPOGL_{t-k} + \sum_{i=0}^{p} \Delta\alpha_4 lnGL_{t-k} \\ & + \sum_{i=0}^{p} \Delta\alpha_5 lnIQ_{t-k} + \sum_{i=0}^{p} \Delta\alpha_6 lnUR_{t-k} + \sum_{i=0}^{p} \Delta\alpha_7 lnRGDPC_{t-k} + \beta_1 lnGHG_{t-1} + \beta_2 lnSOGL_{t-1} \\ & + \beta_3 lnPOGL_{t-1} + \beta_4 lnGL_{t-1} + \beta_5 LnIQ_{t-1} + \beta_6 LnUR_{t-1} + \beta_7 LnRGDP_{t-1} \emptyset ECT_{t-1} + \mathcal{E}_t \end{aligned} \quad (2)$$

Whereas $\alpha_{1-7}$ is the coefficient of short-run, and $\alpha_0$ is the intercept, $\beta_{1-7}$ indicates the coefficient of long-run variables, $\Delta$ is the function of the first difference, $p$ denotes the number of lags, ECT is the error correction term, and $\mathcal{E}_t$ is the error term. It is crucial to ascertain the dependent and independent variables' long-term cointegration. Thus, we apply the ordinary least square (OLS) approach to regress equation (2).

Using the Wald $F$-statistic, the alternative hypothesis—which asserts that there is cointegration between the variables—is compared to the null hypothesis, which maintains that there is no cointegration among the variables in Somalia. The hypothesis is formulated as follows:

$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$|The null hypothesis ($H_0$): the indicators are not cointegrated in the long run.

$H_a : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$|The alternative hypothesis:$H_a$ the indicators are cointegrated in the long run.

## 4. Empirical findings and discussion

### 4.1. Descriptive statistics

Summary statistics of the sampled variables are reported in Table 2. Mean values of GHG (25227.86), institutional quality (6.8), globalization (25.8), political globalization (28.5), economic growth (3.0), social globalization (19), and urbanization (35.5) are observed. GHG emissions is established to have the highest maximum values compared to other parameters. Similarly, GHG is recorded to have the highest standard deviation value, which implies that its values are scattered compared to other sampled variables. GHG, institutional quality, and political globalization are negatively skewed, whereas the rest of the parameters are positively skewed. In contrast, the correlations of the interested variables are also presented in Table 2. All the parameters are positively associated with GHG except institutional quality, which has a negative correlation with GHG.

### 4.2. Unit root test

All the sampled parameters have passed the unit root test and confirmed that they are stationary at the combination of level I(0) and first difference I(1). We contend the existence of long-run cointegration between the dependent variable (GHG) and the explanatory variables—institutional quality,

**Table 2.** Preliminary analysis of the data.

| | GHG | IQ | GLO | POGL | RGDP | SOCGL | URB |
|---|---|---|---|---|---|---|---|
| Mean | 25227.86 | 6.888 | 25.854 | 28.590 | 3.000 | 19.109 | 35.514 |
| Median | 25196.81 | 7.000 | 25.444 | 29.365 | 2.640 | 19.828 | 34.404 |
| Maximum | 27109.09 | 7.000 | 30.344 | 31.311 | 5.790 | 27.481 | 43.816 |
| Minimum | 21684.16 | 6.500 | 24.415 | 24.831 | 1.530 | 12.991 | 29.658 |
| Std. dev. | 1008.856 | 0.211 | 1.500 | 2.152 | 1.280 | 4.712 | 4.4611 |
| Skewness | −1.422 | −1.336 | 1.563 | −0.794 | 0.620 | 0.206 | 0.535 |
| Kurtosis | 7.125 | 2.785 | 4.924 | 2.027 | 2.137 | 1.650 | 2.000 |
| Jarque-Bera | 28.251 | 8.087 | 15.166 | 3.904 | 2.568 | 2.240 | 2.415 |
| Probability | 0.000 | 0.017 | 0.000 | 0.141 | 0.276 | 0.326 | 0.298 |
| Correlation | | | | | | | |
| GHG | 1 | | | | | | |
| IQ | −0.369 | 1 | | | | | |
| GLO | 0.185 | −0.122 | 1 | | | | |
| POGL | 0.039 | −0.289 | 0.120 | 1 | | | |
| RGDP | 0.200 | 0.187 | 0.770 | −0.480 | 1 | | |
| SOCGL | 0.1624 | 0.060 | 0.785 | −0.513 | 0.966 | 1 | |
| URB | 0.336 | 0.114 | 0.782 | −0.401 | 0.964 | 0.937 | 1 |

**Table 3.** Unit root test.

| | ADF | PP | ADF structural break unit root test | |
|---|---|---|---|---|
| Variable | *t*-Statistics | *t*-Statistics | *t*-Statistics | Time break |
| LGHG | −3.768** | −2.454 | −4.146 | 1997 |
| ΔLGHG | −4.624*** | −5.233*** | −13.250*** | 2007 |
| LSOCGL | −3.612* | −2.209 | −4.238 | 2006 |
| ΔLSOCGL | −3.586* | −3.812** | −4.896* | 1999 |
| LPOGL | −1.157 | −1.584 | −8.135 | 2006 |
| ΔLPOGL | −4.985*** | −5.067*** | −6.617*** | 2012 |
| LGL | −1.022 | −1.446 | −4.863* | 2019 |
| ΔLGL | −4.824*** | −4.846*** | −5.715*** | 2014 |
| LIQ | −1.857 | −1.916 | −4.678* | 2000 |
| ΔLIQ | −5.144*** | −5.144*** | −7.026*** | 2006 |
| LURB | −2.391 | −2.381 | −10.00*** | 2007 |
| ΔLURB | −5.723*** | −7.198*** | −7.342*** | 2007 |
| LRGDP | −2.661 | −2.676 | −8.823*** | 2012 |
| ΔLRGDP | −3.231* | −5.166*** | −5.223*** | 2015 |

ADF: augmented Dickey-Fuller test; PP: Philips Perron test; ADF structural break.
*Notes:* Δ denotes the first difference. The *t*-statistics reported are the intercept and trend.

**Table 4.** Long-run coefficient results.

| Variable | Coefficient | Std. error | *t*-Statistic | Prob. |
|---|---|---|---|---|
| lnIQ | −1.018 | 0.362 | −2.814 | 0.013 |
| lnGLO | −0.340 | 1.137 | −0.298 | 0.769 |
| lnPOGL | −0.049 | 0.623 | −0.078 | 0.938 |
| lnRGDP | 0.659 | 0.259 | 2.543 | 0.023 |
| lnSOCGL | −0.835 | 0.368 | −2.266 | 0.039 |
| lnURB | −0.545 | 0.399 | −1.366 | 0.193 |
| Constant | 3.442 | 3.195 | 1.077 | 0.299 |
| Bound *F*-statistics | 7.495 | | | |
| 1% Critical value | 5.691 | | | |

globalization, political globalization, economic growth, social globalization, and urbanization. We have also performed the unit root test of the structural break as presented in Table 3. Structural breaks were considered due to civil conflicts and controlled for in the analysis to ensure robustness and account for disruptions in economic relationships. It underscored that the variables are stationary with the combination of both levels—level and first difference.

The bound test result is displayed in Table 4. The bound *F*-statistic is greater than the upper bound critical value at the 1% significance level, hence confirming that the explanatory variables are cointegrated to GHG emissions in the long run.

**Table 5.** Short-run coefficient results.

| Variable | Coefficient | Std. error | *t*-Statistic | Prob. |
|---|---|---|---|---|
| Δ (lnIQ) | −0.097 | 0.097 | −1.007 | 0.331 |
| Δ (lnGLO) | 0.423 | 0.296 | 1.428 | 0.174 |
| Δ (lnPOGL) | −0.036 | 0.157 | −0.232 | 0.820 |
| Δ (lnRGDP) | 0.115 | 0.030 | 3.811 | 0.002 |
| Δ (lnSOCGL) | −0.330 | 0.094 | −3.505 | 0.003 |
| Δ (lnURB) | −0.499 | 0.111 | −4.509 | 0.000 |
| ECT (−1) | −0.398 | 0.036 | −10.93 | 0.000 |

**Table 6.** Diagnostic tests.

| | |
|---|---|
| $X^2_{SC}$ | 0.968 (0.164) |
| $X^2_{HET}$ | 1.334 (0.274) |
| Normality Test | 0.197 (0.906) |
| Reset test | 2.298 (0.154) |
| Adjusted $R^2$ | 0.84 |

$X^2_{HET}$ and $X^2_{SC}$ are heteroskedasticity and serial correlation, respectively.

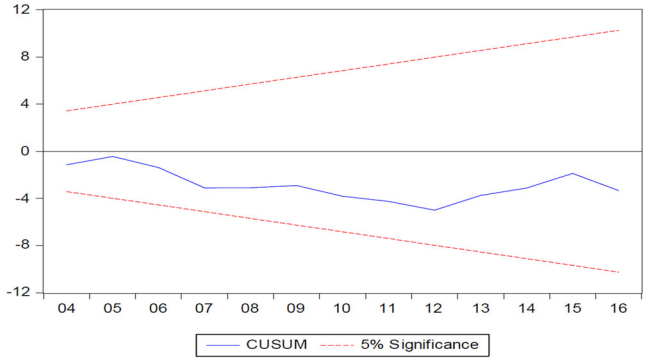


**Figure 2.** CUSUM test.

Furthermore, the long-run coefficients of the sampled parameters are also reported in Table 4. It was observed that institutional quality, economic growth, and social globalization significantly affect environmental pollution in Somalia in the long run, whereas the rest of the sampled explanatory variables are inconsequential in the long run. Interpretively, a 1% increase in institutional quality enhances environmental quality by about 1.01% in the long run in Somalia. Similarly, social globalization improves environmental quality in Somalia in the long run. A 1% increase in social globalization is associated with environmental pollution decreasing by about 0.83% in the long run. On the contrary, economic growth hampers environmental quality in Somalia in the long run. A 1% increase in economic growth impedes environmental quality by about 0.65% in Somalia in the long run.

After examining the long-run coefficients of the parameters, we subsequently estimate the short-run dynamic effects of the sampled parameters. Its result is displayed in Table 5. It was observed that economic growth, social globalization, and urbanization significantly affect environmental pollution in the short run, but other regressors are statistically insignificant. A 1% increase in economic growth leads to environmental pollution increasing 0.11% in the short run. Moreover, social globalization improves environmental quality by about 0.33% in the short run for a 1% increase in social globalization. In the same vein, a 1% increase in urbanization leads to an environmental quality increase of about 0.49% in the short run. More importantly, the ECT is significant and has a negative coefficient, which implies that the model makes convergence.

Further, the diagnostic results of the model, such as the serial correlation, heteroskedasticity, reset test, and normality test, are presented in Table 6. It was observed that the model is free from all the diagnostic problems. The goodness of fit of the model also revealed that the model is better, as shown by the adjusted *R*-squared (0.84). The sampled independent variables explain that 84% of the variations happen in environmental pollution in Somalia. Moreover, the model of the study is reliable, as shown in Figures 2 and 3-CUSUM and CUSUM square tests, respectively.

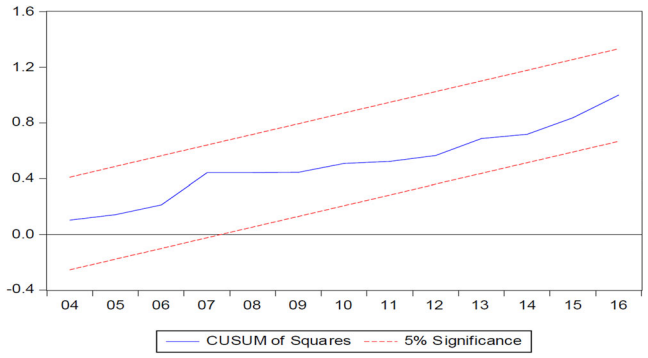


**Figure 3.** CUSUM square test.

**Table 7.** Pairwise Granger causality tests.

| Null hypothesis | *F*-statistic | Prob. |
|---|---|---|
| lnGLO ⇏ lnGHG | 1.250 | 0.307 |
| lnGHG ⇏ lnGLO | 2.248 | 0.131 |
| lnIQ ⇏ lnGHG | 0.936 | 0.408 |
| lnGHG ⇏ lnIQ | 2.597 | 0.099 |
| lnPOGL ⇏ lnGHG | 0.146 | 0.864 |
| lnGHG ⇏ lnPOGL | 0.259 | 0.774 |
| lnRGDP ⇏ lnGHG | 0.361 | 0.700 |
| lnGHG ⇏ lnRGDP | 2.794 | 0.085 |
| lnSOCGL ⇏ lnGHG | 0.422 | 0.661 |
| lnGHG ⇏ lnSOCGL | 8.067 | 0.002 |
| lnURB ⇏ lnGHG | 0.071 | 0.930 |
| lnGHG ⇏ lnURB | 0.152 | 0.859 |
| lnIQ ⇏ lnGLO | 3.832 | 0.037 |
| lnGLO ⇏ lnIQ | 0.355 | 0.704 |
| lnPOGL ⇏ lnGLO | 1.827 | 0.184 |
| lnGLO ⇏ lnPOGL | 0.956 | 0.399 |
| lnRGDP ⇏ lnGLO | 1.326 | 0.285 |
| lnGLO ⇏ lnRGDP | 0.622 | 0.545 |
| lnSOCGL ⇏ lnGLO | 1.252 | 0.305 |
| lnGLO ⇏ lnSOCGL | 0.007 | 0.992 |
| lnURB ⇏ lnGLO | 6.212 | 0.007 |
| lnGLO ⇏ lnURB | 0.737 | 0.489 |
| lnPOGL ⇏ lnIQ | 0.664 | 0.524 |
| lnIQ ⇏ lnPOGL | 4.262 | 0.027 |
| lnRGDP ⇏ lnIQ | 0.811 | 0.456 |
| lnIQ ⇏ lnRGDP | 0.789 | 0.466 |
| lnSOCGL ⇏ lnIQ | 4.317 | 0.026 |
| lnIQ ⇏ lnSOCGL | 1.045 | 0.368 |
| lnURB ⇏ lnIQ | 0.302 | 0.742 |
| lnIQ ⇏ lnURB | 5.433 | 0.012 |
| lnRGDP ⇏ lnPOGL | 1.696 | 0.206 |
| lnPOGL ⇏ lnRGDP | 0.361 | 0.700 |
| lnSOCGL ⇏ lnPOGL | 0.098 | 0.906 |
| lnPOGL ⇏ lnSOCGL | 0.007 | 0.992 |
| lnURB ⇏ lnPOGL | 0.982 | 0.390 |
| lnPOGL ⇏ lnURB | 2.228 | 0.131 |
| lnSOCGL ⇏ lnRGDP | 0.853 | 0.439 |
| lnRGDP ⇏ lnSOCGL | 5.120 | 0.014 |
| lnURB ⇏ lnRGDP | 1.668 | 0.211 |
| lnRGDP ⇏ lnURB | 1.815 | 0.186 |
| lnURB ⇏ lnSOCGL | 1.485 | 0.248 |
| lnSOCGL ⇏ lnURB | 0.648 | 0.532 |

⇏ indicates that the variables do not Granger cause.

### *4.3. Granger causality*

The results of the pairwise Granger causality are reported in Table 7. Several unidirectional causalities from environmental pollution to social globalization and from institutional quality to globalization, urbanization, and political globalization are observed. It also established a unidirectional causality from urbanization to globalization. Finally, economic growth Granger causes social globalization but not the other way round.

**Table 8.** Fully modified least squares (FMOLS).

| Variable | Coefficient | Std. error | *t*-Statistic | Prob. |
|---|---|---|---|---|
| lnGLO | −0.022 | 0.427 | −0.053 | 0.958 |
| lnIQ | −0.719 | 0.112 | −6.414 | 0.000 |
| lnPOGL | −0.041 | 0.238 | −0.175 | 0.862 |
| lnRGDP | 0.064 | 0.043 | 1.498 | 0.150 |
| lnSOCGL | −0.265 | 0.124 | −2.131 | 0.046 |
| lnURB | 0.409 | 0.085 | 4.768 | 0.000 |
| Constant | 9.647 | 0.679 | 14.204 | 0.000 |
| *R*-squared | 0.515703 | Mean dependent var | 10.140 | |
| Adjusted *R*-squared | 0.362767 | *SD* dependent var | 0.028 | |

### 4.4. Robust analysis

To find robust results, we perform FMOLS as a robust analysis. Its result reported in Table 8 revealed that institutional quality, social globalization, and urbanization are statistically significant. Both social globalization and institutional quality improve environmental quality by reducing GHG emissions, whereas urbanization significantly hampers environmental quality by increasing GHG emissions.

### 4.5. Discussion of the result

Social globalization enables the transfer of knowledge, ideas, and information between different countries. It provides people in Somalia with the ability to obtain information regarding sustainable practices, environmental preservation, and renewable technology from various parts of the globe. Enhanced consciousness can result in shifts in attitudes and behaviors regarding the environment, fostering endeavors to preserve and achieve sustainable progress. The disaggregated globalization on environmental quality, namely social and political globalization in Somalia, demonstrates that social globalization significantly and positively influences the reduction of GHG emissions, primarily by enhancing access to environmental information, fostering worldwide activism, and facilitating the dissemination of sustainable behaviors. Although political globalization did not exhibit a statistically significant direct effect over the long term, its impact may nevertheless be indirectly experienced through its interplay with social globalization. Somalia's increasing collaboration with foreign organizations and development partners can augment the scope and legitimacy of socially oriented environmental efforts. Social and political globalization operate synergistically; social globalization fosters community awareness and action, while political globalization—*via* diplomatic relations and international frameworks—strengthens institutional commitment. No evident rivalry was noted between these aspects; instead, their potential complementarity indicates that integrated initiatives utilizing both social outreach and political engagement could further improve environmental results in Somalia.

This result aligns with the recent study conducted by Rong et al. (2024), which concluded that social globalization enhances environmental quality in China. Extensive studies have demonstrated that social globalization promotes environmental quality, such as Lenz and Fajdetić (2021) for the EU, Jahanger et al. (2022a) for 74 developing countries, and Mehmood (2021) in Singapore. On the contrary, social globalization has an insignificant impact on environmental quality in panel data from 180 countries (Farooq et al., 2022). This finding contradicts numerous earlier studies that have indicated that social globalization adversely impacts environmental quality, such as Deng et al. (2022) for a global sample of 107 countries and Akif (2021) for Central and Eastern European countries.

The institutional quality in Somalia has had significant effects on the country's levels of environmental pollution in the long run. In promoting sustainable environmental practices, it is crucial to create high-quality institutions that demonstrate effective governance structures, strong regulatory frameworks, and rigorous enforcement mechanisms. In scenarios when institutions exhibit fragility or suffer from corruption and incompetence, the enforcement of environmental standards may be deficient or ignored, resulting in escalated levels of pollution. On the other hand, robust institutions can create and enforce environmental regulations, oversee adherence to them, and offer rewards for adopting sustainable methods. Institutions that place environmental protection as a top priority may encourage environmental education and awareness, enable the implementation of clean technology, and promote responsible

resource management. Hence, enhancing the quality of institutions is crucial in mitigating environmental degradation in Somalia and securing a sustainable future for its ecosystems and communities. Our finding supports the study carried out by Kwakwa (2023) in African countries, Jahanger et al. (2022b) in 69 developing countries, Ahmed et al. (2020) in Pakistan, and Danish and Ulucak (2020) in Asia-Pacific Economic Cooperation (APEC) countries. However, this result contradicts other studies, such as Amin et al. (2023) in South Asian countries and Azam et al. (2021) in 66 developing countries.

## 5. Conclusion and policy recommendation

Environmental pollution and its associated consequences are worldwide issues that demand a thorough comprehension of effective measures for reduction in emissions. In the specific context of Somalia, a country struggling with distinctive social, political, and environmental obstacles, assessing the impact of social and political globalization, urbanization, and institutional quality on GHG emissions is vital. Therefore, the study aims to investigate the relationship between these variables and environmental degradation in Somalia. This investigation enhances the understanding of the environmental issues faced by the country and provides helpful insights on possible strategies for attaining sustainable development. The study uses the autoregressive distributed lag (ARDL) model, fully modified ordinary least squares (FMOLS) methods, and causality tests to analyze the data.

The empirical results of the bound test indicate that institutional quality, economic growth, and social globalization have had a significant impact on environmental pollution in Somalia in the long run. However, the remaining explanatory variables included in the sample are inconsequential in the long run. Economic growth, social globalization, and urbanization significantly influence environmental pollution in the short run, while other regressors show statistical insignificance. To find robust results, we perform the fully modified ordinary least squares (FMOLS). The findings revealed that institutional quality, social globalization, and urbanization are statistically significant. Both social globalization and institutional quality improve environmental quality by reducing GHG emissions, whereas urbanization significantly hampers environmental quality by increasing it.

Based on the empirical evidence, the study offers several policy implications. The government of Somalia should prioritize enhancing institutional quality and fostering social globalization to alleviate environmental pollution and decrease greenhouse gas (GHG) emissions. Enhancing social globalization requires setting policies that prioritize sustainability and safeguarding the environment. In addition, policies that promote Somalia's integration into the global social sphere, such as educational exchanges, international collaborations, transfer of technology, and awareness campaigns regarding global environmental issues, can significantly contribute to reducing pollution levels and fostering sustainable development. Engaging in partnerships with other countries and international organizations can bolster Somalia's ability to effectively tackle environmental issues.

Furthermore, the policy considerations of enhancing institutional quality to mitigate environmental deterioration in Somalia are significant. Improving institutional quality entails bolstering governance frameworks, fostering openness, and fighting corruption. Firstly, it is essential to build efficient structures and regulatory organizations for environmental governance. These entities should possess sufficient authority and capability to implement environmental legislation, oversee adherence, and levy sanctions for infractions. In addition, fostering transparency and accountability in decision-making processes about the management of natural resources can serve as a deterrent to corruption and guarantee the implementation of sustainable practices. Considering our findings on Somalia's institutional issues, practical and effective environmental policies should concentrate on enhancing local government and fostering community-led initiatives. Establishing locally governed environmental policies under district councils could facilitate pollution tracking and enhance accountability. These policies would not necessitate intricate frameworks and may be bolstered by collaborations with foreign organizations for training and technical support. Furthermore, implementing straightforward permitting mechanisms for handling waste and emissions at the domestic level would enable authorities to more effectively regulate environmental concerns within their constrained capacity. Furthermore, the study's findings indicate that social globalization contributes to emission reduction; hence, Somalia could also gain from awareness efforts

that foster environmental responsibility *via* radio, social media, and community programs—resources already extensively utilized throughout the nation. Minor ecological initiatives, such as afforestation and community clean-up efforts. This might be executed with the assistance of local youth organizations and non-governmental organizations. Such low-cost, inclusive initiatives not only correspond with Somalia's existing institutional framework but also establish a foundation for enduring enhancements in environmental governance.

Conversely, due to the negative impact of urbanization on environmental quality, Somalia's reliance on traditional biomass energy relates to the rising urban population escalating energy demand that adversely affects environmental quality (Warsame, Abdi, et al., 2023). To attain environmental quality, effective urban planning and urban-generated renewable energy are essential. Somalia possesses many renewable energy resources, including wind, hydropower, and solar energy. Investing in and extracting these resources may decrease fossil fuel energy consumption while preserving sustainable economic growth and environmental integrity. Therefore, policymakers should control urban population densities and optimize land resource exploitation by implementing appropriate strategies to significantly improve environmental quality and purify the air. The lack of adequate urban planning in Somalia since 1991 has led to insufficient infrastructure for emerging neighborhoods and has reignited land disputes, exacerbating violence and social instability. Formulating effective urban plans is essential for tree planting, mitigating forest degradation, and managing trash in urban environments.

One of the limitations of the study is that it examined the impact of institutional quality and disaggregate globalization on greenhouse gases. Hence, we suggest that future research should examine the effects of disaggregated globalization on various environmental indicators and different countries.

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## Ethical approval

Not applicable.

## Consent to participate

Not applicable.

## Consent to publish

Not applicable.

## Authors contributions

CRediT: **Hassan Abdikadir Hussein**: Conceptualization, Investigation, Methodology, Writing – original draft; **Abdimalik Ali Warsame**: Data curation, Formal analysis, Investigation, Writing – original draft; **Abdikafi Hassan Abdi**: Writing – original draft.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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## Data availability statement

The data used for the analysis were derived from the following resources available in these public domains:
https://data.worldbank.org/country/somalia
https://www.sesric.org/query.php
https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html
https://freedomhouse.org/countries/freedom-world/scores.

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