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Environmental Quality under Pressure: The Role of Natural Disasters, Migration, Tourism, and Energy Use in South Asia's Ecological Resilience

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ABSTRACT

The capacity of environment quality to withstand and recover from the natural disaster is increasingly compromised. On the other hand increasing population demands the increase in migration, tourism, energy use and economic growth can change pattern of environmental quality. This study investigates the integrated long term and short term impact of natural disaster, migration, tourism, renewable energy use and economic growth on environmental quality in south Asia for the period of 2000-2022. Finding reveals that in long run natural disaster significantly increases the environmental degradation, while migration and tourism are encouraged as both of these variables improve the environmental quality. The renewable energy use and economic growth exerts the negative influence, improving the environmental degradation.in contrast to long term migration and tourism exerts the negative impact on environmental quality while the renewable energy use and economic growth positively influence the environmental quality in shout term. Natural disaster does not immediately influence the environmental quality. This analysis suggests the complex behavior of the factors affecting the environmental quality, convincing the nuanced policy for balanced economic growth with environment sustainability in south Asia.

Keywords: Environmental quality, natural disaster, migration, tourism and renewable energy use.

Introduction:

Natural disaster is an enormous hazard to human societies and environment leading to the unrest and destruction. Natural disaster in the form of hurricane, fireworks and floods is not only threat to the properties of the individuals but also significantly degrades the environment. Recognition of such strong relationship among the natural disaster and environment degradation demands the

crucial approach to manage and mitigate the impact of natural disaster (Coppola, 2015). Natural disaster has both immediate and indirect impact on environment. The immediate impact of natural disaster can be in form of destruction of habitat, polluting water sources and disturbance to natural cycle of nutrients (Cooke *et al*., 2022). The indirect impact includes biodiversity loss, soil erosion, influenced ecosystem and increased vulnerability of species to extinct (Prakash & Verma 2022). Specific change in pattern of environment emerges as a result of different natural disaster, South Asia a region with cultural diversity and dynamic landscape is also exposed to the natural disasters (Afzal & Nishtar 2023). This region has been hardly hit by the earthquakes, floods and landslide in recent history causing damage to the health and economic life of the people. Unfortunately, the significant environmental impact of these events has not received required attention. Geographical location, climate vulnerability and human activities have influenced the natural disaster in South Asia (Noor & Abdul 2022).

South Asia, home to a large number of populations is under the process of economic development (Bose & Jalal 2022). This process is accompanied by environmental challenges and economic objectives. The required economic development compels the region towards industrialization, increased consumption and urbanization (Chikezie *et al*., 2023). However, this set of action has environmental consequences in the region. Industrial expansion, infrastructure development and shift towards resource-intensive production process is a key to economic development in south Asia and can make crucial role in poverty reduction, increased economic opportunities and improved quality of life but on the other hand the delicate ecosystem and natural resources has been under pressure in these activities (Mondal & Palit 2022). Among other influences, the problems related to the economic growth of South Asia are associated with air and water pollution. Industrial emissions, rampant vehicular pollution, inadequate waste management and wastewater treatment practices caused the levels of air and water pollution in the region to skyrocket to the all-time maximum, jeopardizing the well-being of millions of people and overall integrity of local ecosystems (Ameen *et al*., 2023). Another issue refers to deforestation and the loss of habitat caused by urbanization and industrialization. Additionally, economic development of this region has been the aftermath of unsustainable utilization patterns of natural resources in the continent (Jhariya *et al*., 2022).

Similarly, migration for the sake of better economic life, urbanization and globalization are the voluntary migrations and poses a significant impact on environment (Sagarika 2022). Urbanization overcrowds the population of cities damaging the landscape and habitat of nature and resources becomes under pressure as they have to meet the more demand (Prasad 2023) Polluted air and water are the outcomes of unplanned urbanizations. As migration demands for the more land which results in loss of forest making the environment polluted and increase in carbon emission. The mobility of the capital and labor across the border changes the consumption pattern of resources with far-reaching implication for ecosystem. Despite these negative impact on environment the opportunity cost of the environment contributing in the development of region is neglected which

required an integrated approach to address and provide governance for environmental sustainability and adaptation (Basuki *et al*., 2022). South Asia home to diverse culture and large number of populations is marked by the mobility of human nationally and internationally (Ferdous & Ullah 2022). Economic underdevelopment, political instability, climate change and environmental degradation are the factors that derive the mobility in the region (Mbaye & Signé 2022). Migration marks the social, political, economic and environmental implications in the region. The migration in south Asia includes the domestic migration from rural to urban area and international migration across the border. Each of the above type of migration has a significant impact on the environment resulting in change in landscape, change in utilization pattern and affected biodiversity. The urbanization in south Asia changes the landscape leading to deforestation, loss of agriculture land and disturbs ecosystem. Urbanization makes the resource consumption and waste generation centralized in urban area causing environmental degradation and pollution. Cross boarder migration because of economic and political instability has significant environmental impact. Migration overcrowds the routes and destination associated with it leading to the decline in natural resources and cross boarder diseases caused by the migration in form of viruses (Dayrit *et al.,* 2022).

Tourism as a fastest growing industry carries the potential of job provision, economic development and cultural exchange (Dilshod *et al*., 2024). Tourist can choose form the wide capacity of tourist spot ranging from beaches to the historical values as a destination. However, the tourism expansion raises the importance of environmental impact long term sustainability of ecosystem because of tourism (Baloch *et al*., 2024). The impact of tourism on the environment is often seen as having two sides. On the one hand, tourism can offer significant financial rewards for environmental preservation and conservation, helping to keep natural ecosystems and places of cultural significance intact (Zhang *et al*., 2023). Ecotourism and sustainable tourism initiatives are examples of responsible tourism practices that work to reduce their negative effects on the environment while fostering community involvement, environmental education, and biodiversity conservation. The delicate and ecologically sensitive places are threatened more when the tourist are not aware about the laws and values of destination (Danilović *et al*., 2024). The deforestation, soil erosion and polluted air are the possible outcomes of the development of infrastructure for the tourism. Development of infrastructure aims to provide the facilities to the tourist in form of transportation, resorts and lodging facilities is essential. Moreover, the activities related to the tourism on large scale such as adventure, wildlife and cruise ship tourism have more potential to degrade the environment and ecosystem and causes the extinction of endangered species (Guo & Li 2024).

The use of sustainable energy source has been concerning for the countries to increase the growth rate and protect the environment. A continuous use of fossil fuel as energy sources degrades the environment and leads to global warming which encourages the use of renewable energy source in the region in order to avoid the environmental degradation associated with the growth of

economies (Kartal 2022). Renewable energy is generated from the natural resources like wind, solar and water causing a decrease in greenhouse gases emission and mitigates the pollution to air and water protecting the environment quality (Rahman *et al*., 2022). Sustainable development can be achieved with the reliance on the sustainable energy sources such as hydropower plants, solar plants and wind turbines. The underlying cause is to mitigate the negative impact of energy use on environment by shifting from non-renewable energy source to the renewable energy use. The use of renewable energy protects the environment degradation up to greater extent and enhances the energy security (Subramaniam *et al.,* 2023). However, the extensive use of renewable energy sources has significant negative impact on the environmental quality (Chu & Le 2022). The development of infrastructure for the renewable energy source degrades the environment with the change in landscape, fragmentation of natural habitat and use of natural resources to produce the renewable energy. Use of Natural resources such as wind, solar and water has complicated procedure to produce energy and store that energy is batteries and grids, because of scope of these storages the use of batteries and technologies is a significant threat to environment quality that goes beyond the natural resource extraction and recycling. This complex behavior of the renewable energy use demands a thorough understanding of environmental impact of the renewable energy use for the policymakers.

Natural disaster have profound and significant impact on environmental quality, such events leads to the loss of biodiversity, soil, water and results in to destruction of ecosystem. After math of natural disaster is deforestation, land loss pollution and recovery activities. Stated discussion of the natural disaster leaves us with the following research first, Do natural disaster causes any changes in environmental quality in south Asian economies? Migration and Tourism are such human activities which can influence the environmental quality in many ways. Tourism financially beneficial can result in environmental degradation if not practiced sustainably. High tourist can lead to loss of resources, waste generation and pollution. Migration can restrain resources due to increase in demand of land, water and energy. However both migration and tourism have the potential to positively affect environment quality if managed efficiently. Second, has migration and tourism become the driving factor to change the environmental quality? Renewable energy use is encouraged to decrease the carbon emission for the protection of environmental quality yet its infrastructure development and overuse can have environmental drawbacks such as resource depletion and land use change. The economic growth to improve living standards often possesses the depletion of environmental quality due to increased industrial production and waste generation. However sustainable economic growth and transition to cleaner energy can improve environmental quality. Finally, does renewable energy use and economic growth cause deterioration of environmental quality?

Based on above research question study is guided by the following research objectives.

1. To find out how the occurrence of natural disaster disrupt the environment quality of the south Asian economies.

2. To investigates how migration and tourism changes the quality of south Asian economies.

3. To find out how renewable energy use and economic growth impacts the environmental quality in panel of south Asian economies.

Literature review:

Natural disasters have profound significant impact on the environment posing challenges for the ecosystem and sustainable development. Understanding the impact of natural disaster has been elaborated by the literature review examining the global impact. This review helps to inform management about the resilience building efforts in the vulnerable region. (Ianoş *et* al., 2019) Examines the impact of the land use change due to natural disaster and found that natural disaster especially in form of flooding significantly results in land use change in form of deforestation and rapid urbanization as expected. The study reveals that the urbanization further leads to the provision of natural disaster facilities such as deaths caused by floods, landslide, heat wave and other socio economic impacts. The studies highlight the outcomes of unplanned urbanization in the form of severe damages caused by natural disasters. The economic structure of the affected region is disturbed by the natural disaster (Ashraf *et al*., 2013) reveals in his study that when flood hit the Pakistan in 2012 the agriculture, transportation and services sectors are adversely affected. The decreasing demand y these mentioned sectors lead to the economic loss and makes these sectors dysfunctional. Study suggests the government to formulate the infrastructure in order to mitigate the impact of the natural disasters to keep the economic life of the population in function. Similarly, another study by (Hossain *et* al., 2016) highlights the impact of natural disaster on the agricultural land and poverty reduction in which the study reveals that the natural disaster causes a significant decrease in agriculture production. The impact of natural disaster on environment has multiple and complex dimensions as the literature on the impact of COVID-19 remains unsettled. (Dou *et al*., 2022) contributes in understanding the impact natural disaster on CO2 emission. Study interestingly founds that the impact of natural disaster is negative in CO2 emissions. He founds that energy consumption act as mediating factor and technology as a moderating factor between natural disaster and carbon emission suggesting the importance of the energy consumption in policy formulation of the environment and disaster management. On the hand the environment protection is responsibility of the state which is paid with the tax collection in a similar another research by (Baccini & Leemann 2021) tries to find out the favor of the climate protection policy by the voter In case of natural disaster in which he finds out that pro-climate voting increase sizably by 20% after experiencing the floods presenting the change of behavior of public. The views of individuals about the environment are affected by the natural disasters, study by (Kalatzi *et al*., 2023) founds that the views of individuals about the environment are different before and after the

occurrence of the natural disasters especially when the disaster events are extremes, evidence indicates that the death caused by natural disasters in nearby country change environment salience attitude of the individuals clarifying that the impact of natural disasters are not only limited in the domestic boundaries of the affected countries but have far reaching psychological impact on the public opinion and policy in nearby countries. Environmental Impact of the natural disaster is even worse by the irresponsible behavior of the population as a study by (Sholihah *et al*., 2020) shows that the violations made by the individuals in order to make the factories along the river bank makes the water more polluted and flood in such river threats more to the affected people that the polluted water can worse the damage so in order to mitigate such impact of the disaster the strong polices are recommended to make accountable the responsible person of such events. Similarly, another community affected by the extreme events of the water are the fisher's community study by (Turner *et al*., 2020) founds that hurricane significantly changes the vulnerability of the fisher's community to the climate and shaping their adaptive behavior for the climate change resilience in fishing community towards climate change. Based on the cited literature, the first hypotheses have been proposed:

H1: Natural disasters are likely to deteriorate the environmental quality of south Asia.

Migration, a global phenomenon shaped by economic, political, and social factors, has significant implications for environmental quality. As populations shift across regions and countries, they bring about changes in land use, resource consumption, waste generation, and pollution levels. Understanding the multifaceted relationship between migration and environmental quality is crucial for developing sustainable policies and practices. This literature review aims to synthesize existing research on the impacts of migration on environmental quality and identify key findings, gaps, and future research directions. Migration for internal migrants in urban areas is particularly influenced by the quality of the environment. The hygienic cities having the improved quality year significantly attracts the migrates from the rural areas so this study highlights that the migration and environmental Quality are co-ordinated with each other as the migration can improve the environmental quality through the demand of cleaner living conditions (Sun & Zhao 2023). Impact of migration on Environment quality can be positive negative or insignificant (Xia 2022) explorers the complex relationship between migration and environmental quality. This Complex behavior is because of diverse economic and social factor influence policies. The change in trade due to globalization makes it complex to understand the impact of migration environmental quality. Migration caused by the different factor such as unemployment, poverty, landlessness and financial difficulties offering the migrants higher economic facilities for healthy life.

Tourism as a major global industry contributes significant positive and negative impact on the environment quality as highlighted in early studies. A study by (Baloch *et al*., 2023) Finds the impact of tourism on environmental quality, indicates that tourism have both positive and negative impact on the environment; contributing to the air and water pollution with the waste generation

and resource depletion are the negative impact of tourism on environment while conservation through a region with the proper development and community-based relation can help to mitigate the negative impact on Environment quality. another attempt by (Pata *et al.*, 2022) evaluates the impact of tourism-based energy consumption on the ecological footprint in turkey for the time period of 165-2017, findings indicates that increase in tourist arrival has negative impact on environment quality with the increase in ecological footprints in long-run supporting the kruznets hypothesis curve for the turkeys tourist industry. Tourism contributes the share of 10% to global GDP increasing the challenges in the form of environmental degradation. (Cevik 2023) Finds the impact of tourism on environment quality with measurement of CO2 emission, study reveals that the international tourist arrival have significant impact on CO2 emission demanding the comprehensive polices to reduce the negative impact of tourism on environment quality such as less use of fossil fuel based energy. Tourism industry leads to increase in consumption and economic growth at the cost of environment degradation. (Irfan *et al*., 2023) Highlights that the tourism related food industry significantly increases greenhouse gases emission especially CH4, while tourism based transport increases significant amount of CO2 emission. Tourism increases energy consumption which leads to compromise on the environment quality indicating a significant contribution of tourism in environmental degradation. The negative impact of tourism on Environment quality can be mitigated by innovation in tourism. Study by (Ahmad *et al*., 2022) uncovers the impact of tourism innovation on Sustainable environment and quality, Tourism innovation will help in pollution reduction. Finding suggests that innovation improves environmental quality with Economic prosperity with the Awareness of people is most important for sustainability. Based on above cited literature another hypothesis has been proposed.

H2: migration and tourism are positively linked with environmental quality

Use of renewable energy has increased to preserve the environmental quality. Literature highlights the challenges and potential of the renewable energy on environmental outcomes. (Anser *et al*., 2022) Examines the relationship between renewable energy and environmental quality for Asian countries from 1990 to 2018, the study revealed that wind power and Biomass significantly improves the environment quality with economic growth as renewable energy reduces the use of fossil fuel causing decrease in emission of greenhouse gases. Environmental degradation resulting in the form of environmental disaster becomes a concerned for the countries to control the environment quality. (Rahman & Alam 2022) evaluates the role of variables which are crucial for environment in Australia. Non-renewable energy use has increased carbon emission and renewable energy use has decreased carbon emission in Australia with the validity of environmental kruznets curve hypothesis highlighting the importance of the use of renewable energy with innovation. Another study by (Gavkalova *et al*., 2o22) finds the impact of the Innovation trends in Renewable Energy generation for effecting air pollution in world. the study show that some countries with moderate and low growth rate of renewable energy use cause decrease in emission of carbon dioxide while some countries like Canada Mexico and Poland does not always cause decrease in

carbon emission with increase in use of renewable power generation. The study helps to adopt the strategies for environmental protection in world. Developing regions are striving for the economic development which requires energy use as a key for sustainable development along environmental protection. The study by (Khan *et* al., 2023) revealed that fossil fuel causes degradation of environment quality and use of renewable energy along with the human capital significantly improves environmental quality in sub-Sahara region. Suggesting innovation in the renewable energy and discourages the non-renewable energy use. (Chen *et al.,* 2023) compares the impact of renewable energy and non-renewable energy on carbon emission in china, findings indicates that renewable energy source helps to decrease air pollution while non-renewable energy use causes pollution in the air, although Chinese government are investing in renewable energy sources but that is insufficient to meet the demanded energy for large Chinese economy due to which Reliance on fossil fuel is still heavy. The study encourages the technological advancement for renewable energy source use. Another study by (Candra *et al*., 2023) provides the comparison for impact of renewable energy use on economic growth and environmental quality in middle income countries and high income countries indicating that renewable energy use has significant impact on greenhouse gases emission in middle income countries as compared to the higher income countries. This study reveals that renewable energy has significant impact on mitigating pollution in middle income countries suggesting the advance sustainable development to promote environmental quality with the use of alternative to fossil fuels in middle income and high income countries.

The relationship between economic growth and environmental qualities and important aspect as it explodes the challenges faced for economic development by environmental degradation this literature explodes the relationship among these two stated variables. South Asia region with the developing economies (Murshed *et al*., 2022) considers that process of economic growth demands the use of energy resources. Study confirms the validity of environmental kruznets curve hypothesis for South Asian Economics. Indicating the initial economic growth deteriorates the environmental quality later on improves environmental quality. This study critically highlights the role of renewable energy use in reducing ecological food friends for sustainable environmental improvement in South Asia. (Ekonomou & Halkos 2023) highlights the relationship between economic growth and environmental quality. Study revealed that environmental condition is worsens with increase in economic growth with the most significant impact results in carbon dioxide emission from economic activities. While this environmental degradation by the economic activities varies across the different countries depending on different kind of energy use. Moreover study suggests that the impact of economic growth on Environment quality can be mitigated by the use of renewable energy resource. Another study by (Xing *et* al., 2023) investigates that there are some economic factors that affect the environmental quality, those economic factors are populous prosperity and innovation in South Asian economy for the period of 1990 to 20 2019. Findings show that environmental kruznets curve with inverted U shape is not supported among these variables indicating that Technology and innovations can facilitate the achievement of

economic growth without damaging the environmental quality. (Ali *et al*., 2023) evaluates the environmental Nexus between globalization economic growth and environmental quality in South America. The finding reviews that environment pollution increase with economic growth and this environmental pollution decreases with increasing use of renewable energy resource in long and short term which provide a potential policy measures for the sustainable development. Global warming causing degradation in Environmental quality is mainly driven by the carbon emission used for the economic development in region. (Rani *et* al., 2022) evaluates the Nexus between financial development in achieving sustainable economic growth and environmental quality in South Asian countries. Results show that there is inverted U shaped relationship between the carbon emission and economic growth. That with increase in economic growth the carbon emission will increase initially then with further economic growth environmental degradation will reduce. The study proposes that efficient financial management can help to reduce environmental pollution with economic growth.. Above cited literature propose another hypothesis.

H3: renewable energy use and economic growth are likely to contribute decrease in the environmental quality

There is absence of collective research on the integrated impact of the natural disaster, migration, tourism, renewable energy use and economic growth on environmental quality in south Asian economies. Few studies provide impact of these variables under one research framework. While there has been substantial work on the impact of these individual variables on the environmental quality there is a significant gap in literature for the impact of these explanatory variables on dependent variables within the context of south Asian economies as the existing studies focus on individual and isolated factors. Furthermore, the dynamic of south Asia with increasing rapid population, economic development and vulnerability to the natural disaster are neglected in this context. This study targets to fill the existing research gap by providing a comprehensive analysis of the integrated impact of the natural disaster, migration, tourism, renewable energy use and economic growth on environmental quality in south Asian economies. Figure 1 shows the hypothesized summary of the study.

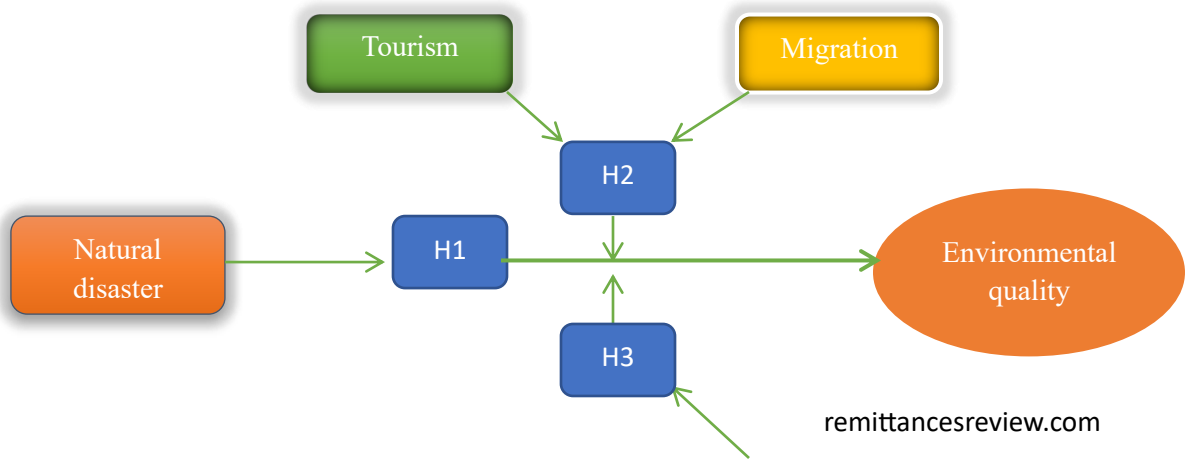

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Figure: 1 Hypothesized Summary of the Study

Source: Self-extract

3. Theoretical frame work

The impact of economic growth on environmental quality was highlighted by the environmental krunets curve (EKC). The environmental kruznets curve suggest that environmental degradation increases with the increase in economic growth at start but after reaching a certain level of environmental degradation decreases with the increase in economic growth. The inverse u shaped relationship among economic growth and natural disaster is crucial to find out the implication of the study along with the impact of the renewable energy which act as catalyst for economic activities. In short run economic growth and energy consumption leads to increase in the emission of carbon dioxide with the development of infrastructure and industries expansion to support the process of structural transformation to industrialization in south Asia. The sustainable economic development of the region forces to invest in environment friendly energy regulations achieving improved environment quality.

Sustainable development theory provides the framework for balancing the environmental protection along the economic development. Tourism and migration a traditional stressor for the environmental quality are highlighted as the rescuer of the environment under the right circumstances. It suggests the needed polices for the economic activities such as tourism and migration along with the environmental protection in the region to be sustainable. In long run the sustainable migration can bring the skilled workers and innovation for the efficient and cleaner production while sustainable tourism can help in preservation and improvement of environment quality. However, in short term the migration and tourism can stress the resource use and infrastructure development can deteriorate the environmental quality.

The increasing intensity and frequency of natural disaster is damaging environmental quality in south Asia. Theories of environmental resilience are important to find out the shocks and recovery from natural disaster exerted on the ecosystem. In long run the repeated shocks and often disaster events make it difficult for the ecosystem to recover and environmental quality keeps deteriorating. However, in short run the immediate impact of natural disasters on environmental quality can be mitigated by the adaptive approach

Theories related to the energy use highlights the tradeoff between cost of installing infrastructure and environmental benefits from the energy use. In short run the transition from fossil fuel to renewable energy use can help in immediate reduction of the carbon emission. While in long run the development cost of the infrastructure for renewable energy use must balance the output created by energy use considering the protection of environmental quality.

These presented frameworks will collectively analyze the impact of the natural disaster, tourism, migration, renewable energy use and economic growth on environmental quality in south Asia. Highlighting the needs for the sustainable and integrated polices for the economic expansion along environmental conservation.

4. Methodology:

Data sources

Study used in Environmental quality denoted by EQ as a response variable whereas Natural disaster to a resume renewable energy migration and economic growth were used as regressive. Study used the data collected from panel of Asian economy namely Bangladesh India Nepal Afghanistan Sri Lanka while Maldives and Bhutan economy were excluded due to non-availability of a data for these given variables. Data was collected from 1999 to 2022 from the world development indicators for all variables other than Natural disaster which was collected from EM-DAT, published by the World Bank. Table 1 shows the list of variables and their measurements. Table no 1 shows the list of the variables

Table: 1 List of Variables

Variables	Symbols	Measurements	source
Environmental Quality	EQ	CO2 emissions (kt)	WDI
Natural Disaster	ND	total damages caused by natural disaster in terms of us dollar	EM-DAT
Migration	MIG	Net migration	WDI
Tourism	TR	International tourism, receipts (% of total exports)	WDI
Renewable energy	RNEC	Renewable energy consumption (% of total)	WDI

Economic Growth	EG	GDP per capita growth (annual %)	WDI

The objective of the study is true determine the condition of environment in selected South Asian countries which are mostly developing economies as these countries are going under the process of structural transformation which is a threat to the environment in long run. In December 2021, $20 billion for granted to the developing countries to protect the environment. According to the agreements the countries are responsible to clean the environment, secondly these nations are rich with the population accounts for the 25% of world population are in excessive need of the economic activities which ultimately disturb the environment balance because population depends on the industrialization. These reasons make the environment of the region unpredictable and difficult to control in South Asia.

Short run

$$\Delta(EQ)_{i,t} = \alpha_0 + \alpha_1 EQ_{i,t-1} + \alpha_2 \Delta \sum_{i=1}^{p} ND_{1,i,t-1} + \alpha_3 \Delta \sum_{i=1}^{q} MIG_{1,i,t-1} + \alpha_4 \Delta \sum_{i=1}^{r} TR_{1,i,t-1} + \alpha_5 \Delta \sum_{i=1}^{s} RNEC_{1,i,t-1} + \alpha_6 \Delta \sum_{i=1}^{u} EG_{1,i,t-1} + \varepsilon_{i,t}$$

Long run

$$\Delta(EQ)_{i,t} = \beta_0 + \beta_1 EQ_{i,t-1} + \beta_2 \sum_{i=1}^{p} ND_{1,t-1} + \beta_3 \sum_{i=1}^{q} MIG_{1,t-1} + \beta_4 \sum_{i=1}^{r} TR_{1,t-1} + \beta_5 \sum_{i=1}^{s} RNEC_{1,t-1} + \beta_7 \sum_{i=1}^{u} EG_{1,t-1} + \mu_{i,t}$$

Short run & Long run:

$$\Delta = \alpha_0 + \alpha_1 EQ_{i,t-1} + \alpha_2 \Delta \sum_{i=1}^{p} ND_{1,i,t-1} + \alpha_3 \Delta \sum_{i=1}^{q} MIG_{1,i,t-1} + \alpha_4 \Delta \sum_{i=1}^{r} TR_{1,i,t-1} + \alpha_5 \Delta \sum_{i=1}^{s} RNEC_{1,i,t-1} + \alpha_6 \Delta \sum_{i=1}^{u} EG_{1,i,t-1} + \beta_0 + \beta_1 EQ_{i,t-1} + \beta_2 \sum_{i=1}^{p} ND_{1,t-1} + \beta_3 \sum_{i=1}^{q} MIG_{1,t-1} + \beta_4 \sum_{i=1}^{r} TR_{1,t-1} + \beta_5 \sum_{i=1}^{s} RNEC_{1,t-1} + \beta_7 \sum_{i=1}^{u} EG_{1,t-1} + \varphi_{i,t}$$

Where, $\mu_{i,t} + \varepsilon_{i,t} = \phi_{i,t}$

Error correction term:

$$\text{ECT} = \alpha_0 + \alpha_1 EQ_{i,t-1} + \alpha_2 \Delta \sum_{i=1}^{p} ND_{1,i,t-1} + \alpha_3 \Delta \sum_{i=1}^{q} MIG_{1,i,t-1} + \alpha_4 \Delta \sum_{i=1}^{r} TR_{1,i,t-1} + \alpha_5 \Delta \sum_{i=1}^{s} RNEC_{1,i,t-1} + \alpha_6 \Delta \sum_{i=1}^{u} EG_{1,i,t-1} + \beta_0 + \beta_1 EQ_{i,t-1} + \beta_2 \sum_{i=1}^{p} ND_{1,t-1} + \beta_3 \sum_{i=1}^{q} MIG_{1,t-1} + \beta_4 \sum_{i=1}^{r} TR_{1,t-1} + \beta_5 \sum_{i=1}^{s} RNEC_{1,t-1} + \beta_7 \sum_{i=1}^{u} EG_{1,t-1} + \mu_{i,t} + \varepsilon_{i,t}$$

Where EQ= Environment quality, ND= Natural disaster, MIG= Migration, TR=Tourism, RNEC= Renewable energy use, EG= Economic Growth.

Δ denotes the change in the variable and ∈ shows the error term which indicates the lack of goodness to fit

5. Results and Discussion

Table 2 provides the summary statistics of the all dependent and independent variables. The mean value is presenting the range in magnitude of the all variables with EQ having the highest mean and MIG having the negative mean indicating the outflow of the migration. Data is highly skewed presenting the asymmetry among the ND and EG with skewness values. The value of kurtosis presents that ND, EG and MIG have heavy tails with presence of outlier

Table 2: Descriptive statistics

	EQ	EG	MIG	ND	RNEC	TR
Mean	21958234	3.093294	-311618.3	1759589.	48.86715	8.013735
Median	7246052.	3.452108	-210288.5	4032.000	46.60000	5.373456
Maximum	1.02E+08	17.14353	1327074.	29886141	91.31000	29.38127
Minimum	748720.0	-22.96530	-2290411.	0.000000	12.61000	0.359391
Std. Dev.	35091232	4.495675	497828.9	4682295.	20.08319	7.599959
Skewness	1.720935	-2.610975	-1.346416	4.197231	0.523534	1.324194
Kurtosis	4.082431	17.39143	7.357815	22.48515	2.729179	3.729659

Correlation matrix presents the relationship among ll the six stated variables. There exist a positive correlation between EI and EG of value 0.175 with indication that economic growth slightly increase with increase in environmental degradation. The correlation between migration and economic growth is insignificant with negative value. There is a strong positive correlation of 0.459 among natural disaster and environmental degradation indicating increase in natural disaster does cause increase in environmental degradation. Natural disaster and migration are significantly correlated. The use of renewable energy is negatively strong correlated with environmental degradation which indicates that renewable energy use has negative impact of environmental degrad ation. Tourism shows negative correlation with the environmental degradation presenting increase in trade may be linked to reduction in environmental degradation. Tourism and renewable energy consumption are positively correlated. Other variables such as MIG and ND, MIG and RNEC are not statistically strongly correlated. Table 3 shows the correlation probability.

Table 3: Correlation probability

Correlation Probability	EI	EG	MIG	ND	RNEC	TR
EI	1.000000					

EG	0.174925	1.000000				
	0.0360	-----				
MIG	-0.116832	-0.122036	1.000000			
	0.1632	0.1451	-----			
ND	0.459400	-0.006555	-0.170998	1.000000		
	0.0000	0.9379	0.0404	-----		
RNEC	-0.252996	0.095874	0.009549	-0.130693	1.000000	
	0.0022	0.2530	0.9096	0.1184	-----	
TR	-0.276050	0.018089	0.262133	-0.165178	0.648526	1.000000

	0.0008	0.8296	0.0015	0.0479	0.0000	-----

Significance of all the variables is checked at level and 1st difference in unit root test under the Levin, Lin & Chu t* Test , Im, Pesaran and Shin W-stat , ADF - Fisher Chi-square and PP-Fisher Chi-square test. Thes test help to determine whether a time series data is stationary or not (having unit root with the p-value below 0.05). At level the under the Levin, Lin & Chu t* Test the variables EI and MIG reject the null hypothesis, under the test Im, Pesaran and Shin W-stat EI and MIG fail to reject the null hypothesis. According to ADF & PP- Fisher Chi-square EI reject the null while MIG fail to reject the null hypothesis.

The same tests are applied at first difference which is mostly used to achieve the stationary of the time series. Almost all the variables show the strong rejection of the null hypothesis with the p-value equal to 0.0000 presenting the stationary of all the variables at first difference. Table 4 shows unit root test.

Table 4: unit root test

Level						
TESTS	EI	ND	ITOUR	MIG	RNEC	EG
Levin, Lin & Chu t*	-1.67102 (0.047)	-5.57811 (0.0000)	-1.73306 (0.0415)	-4.73684 (0.0000)	-2.41248 (0.0079)	-2.84877 (0.0022)
Im, Pesaran and Shin W-stat	-1.26275 (0.103)	-4.97050 (0.0000)	-1.51393 (0.0650)	-5.40046 (0.0000)	0.11880 (0.5473)	-2.36254 (0.0091)
ADF - Fisher Chi-square	21.0214 (0.0501)	46.8263 (0.0000)	17.1663 (0.1434)	51.6028 (0.0000)	11.3029 (0.5032)	29.8268 (0.0030)
PP - Fisher Chi-square	34.9196 (0.0005)	81.0791 (0.0000)	16.2980 (0.1780)	94.4116 (0.0000)	7.10454 (0.8506)	41.6753 (0.0000)
	1st difference					
TESTS	EI	ND	TR	MIG	RNEC	EG
Levin, Lin & Chu t*	-8.78302 (0.0000)	-9.06931 (0.000)	-2.40728 (0.0080)	-12.5569 (0.0000)	-2.76058 (0.0029)	-7.20331 (0.0000)
Im, Pesaran	-9.62336 (0.0000)	-9.94743 (0.0000)	-4.63503 (0.0000)	-13.5582 (0.0000)	-3.30013 (0.0005)	-7.39131 (0.0000)

and Shin W-stat						
ADF - Fisher Chi-square	93.7607 (0.0000)	97.1764 (0.0000)	43.7782 (0.0000)	166.504 (0.0000)	32.2800 (0.0013)	70.9316 (0.0000)
PP – Fisher Chi-square	541.540 (0.0000)	969.116 (0.0000)	94.6594 (0.0000)	966.000 (0.0000)	63.4057 (0.0000)	323.381 (0.000)

Wald test used to find out the joint statistical significance of all the variables jointly in table. The F-statistics of 11.59636 with degree of freedom as 5 and the probability value of 0.0000 shows that the null hypothesis can be strongly rejected which indicates that at least one independent variable has significant impact on dependent variable. Similarly, the Chi-square value of 57.98182 with 5 degree of freedom and probability value of 0.0000 indicates the rejection of the null hypothesis, presenting that coefficients are jointly significant overall the independent variables are statistically significant to explain the variation in dependent variable. Table 5 shows the Wald Estimates.

Table: 5 Wald Estimates

Test Statistic	Value	df	Probability
F-statistic	11.59636	(5, 137)	0.0000
Chi-square	57.98182	5	0.0000

In long-run one unit increase in the Migration leads to improve the environmental quality significantly by 0.0002 units, natural disaster has significant positive impact on carbon emission causing the environment quality to deteriorate by 1.22E-09 units with increase in one unit of the natural disasters. Tourism has significant positive impact on environmental quality, one unit increase in the tourism leads to improve the environment quality by 0.05 units. Renewable energy has significant negative impact on environment quality; one unit increase in the renewable energy causes the environment quality to decrease by 0.012 units. The significant impact of economic growth indicates that one unit increase in economic growth cause the decrease in environmental quality by 0.01 units.

In short term change in migration have significant negative impact on the environmental quality similarly tourism have short term significant negative impact and renewable energy consumption have positive impact on the environmental quality and economic growth have positive impacts on environmental quality whereas, Natural disaster does not possess a significant impact on environmental quality in short term. Table 6 shows the ARDL Estimates.

Table: 6 ARDL Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
MIG	-0.000241	8.47E-06	-28.47609	0.0000
ND	1.22E-09	6.16E-11	19.77031	0.0000
TR	-0.058030	0.001214	-47.79971	0.0000
RNEC	0.012515	0.000308	40.67326	0.0000
EG	0.010061	0.000229	44.01326	0.0000
Short Run Equation				
COINTEQ01	-0.450652	0.227672	-1.979392	0.0535
D(LNEI(-1))	-0.324819	0.247316	-1.313373	0.1953
D(LNEI(-2))	-0.147569	0.255727	-0.577059	0.5666
D(LNMIG)	0.000122	4.50E-05	2.703528	0.0095
D(LNMIG(-1))	3.12E-05	2.92E-05	1.069040	0.2904
D(ND)	7.32E-09	1.32E-08	0.553656	0.5824
D(ND(-1))	-1.10E-07	1.08E-07	-1.017766	0.3139
D(TR)	0.023926	0.010490	2.280872	0.0270
D(TR(-1))	0.024625	0.018285	1.346750	0.1844
D(RNEC)	-0.010134	0.005135	-1.973316	0.0542
D(RNEC(-1))	0.001417	0.003658	0.387402	0.7002
D(EG)	-0.007438	0.003435	-2.165316	0.0354
D(EG(-1))	-0.005503	0.002477	-2.221515	0.0311
C	7.592241	4.117814	1.843755	0.0714
@TREND	0.003908	0.003031	1.289399	0.2034
Log likelihood		396.8047		

Impulse response provides the dynamic effect of independent variables on environmental quality up to 10 years. Results of impulse response show that initially natural disaster and migration have negative impact on the environmental quality indicating disturbance in short term, possibly due to lack of adaptation strategies and resources flow. Economic growth and renewable energy also shows negative impact while tourism shows a slightly positive effect initially. However by 2025 the impact of natural disaster and migration turns positive indicating the reverse of initial loss leading to increase in the environmental quality. Tourism bounds back negatively along with the decrease in the economic growth. Renewable energy shows significant negative impact. From 2026-2032 the impact of these variables starts to fluctuate presenting the nonlinear relationship among the variables. Natural disaster, migration and tourism represent some time positive and sometime negative relationship among the variables presenting complex interplay among the variables with the short term disruption being adjusted in long run. Renewable energy consumption after the initial positive impact reverses with minor fluctuation. Economic growth impact generally diminishes overtime period and becomes less significant in long run. Overall these results show a nuanced relation among environmental and economic interactions. Table 7 shows the impulse response function.

Table: 7 Impulse responses

Period	ND	MIG	TR	RNEC	EG
2023	**0**	**0**	**0**	**0**	**0**
2024	0.080526	0.102800	-0.058373	0.026131	0.026182
2025	-0.035603	-0.061209	0.078663	-0.147679	-0.005802
2026	**-0.** 007266	0.004145	0.059248	0.042709	-0.015880
2027	0.010016	-0.014376	-0.038220	-0.012992	-0.026354
2028	0.000672	0.007872	-0.008497	-0.005138	0.008719
2029	0.005547	0.000757	0.004258	-0.003188	-0.003989
2030	-0.002231	-0.001964	0.002404	0.002680	-0.001377
2031	0.001242	0.000645	0.001324	0.001554	-0.000299
2032	0.000507	-0.000310	-0.001736	-0.000594	-0.000593

The magnitude impact of the independent variable on dependent variable is presented by Variance decomposition. Results of the variance decomposition indicates that natural disaster has the highest

magnitude value of 4.304797 indicating that by 2032 carbon emission in selected south Asian economies will increase deteriorating the environmental quality due to natural disaster by almost 4.5 percent. The next highest impacting variable is economic growth suggesting that the environmental quality will diminish due to economic growth by 0.6% which is further followed by migration and tourism with the magnitude of 0.4% and 0.3% respectively. The least impact is exerted by the use of renewable energy on environmental degradation with the magnitude of 0.04%. Table 8 shows the variance decomposition.

Table: 8 Variance Decomposition

Period	S.E.	EI	MIG	ND	TR	RNEC	EG
2023	1048225.	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2024	1296070.	96.27645	0.009223	3.680219	0.004709	0.009831	0.019567
2025	1550988.	96.00370	0.084336	3.672238	0.014192	0.013417	0.212116
2026	1753442.	95.73657	0.129760	3.868584	0.017561	0.032590	0.214933
2027	1940320.	95.47991	0.173459	3.982139	0.029030	0.037030	0.298437
2028	2110750.	95.23777	0.217706	4.077797	0.061306	0.042054	0.363366
2029	2269238.	95.00043	0.264233	4.152702	0.108264	0.043465	0.430903
2030	2417865.	94.77410	0.308982	4.213311	0.169305	0.043431	0.490870
2031	2558211.	94.55806	0.352042	4.263340	0.240220	0.042231	0.544104
2032	2691483.	94.35417	0.392552	4.304797	0.317838	0.040439	0.590204

Using Pairwise Dumitrescu Hurlin Panel Causality Tests, the results shows that tourism will cause migration but migration does not cause tourism due to insignificant probability. Change in renewable energy use affect migration pattern potentially due to economic opportunity. Similarly the economic growth has significant influence on migration trend suggesting that improvement in economic conditions can drive migration flows. According to results natural disasters are also caused by the economic growth. Table 9 shows the Causality Tests.

Table: 9 Causality Estimates

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
TR [MIG	5.95149	3.46856	0.0005

RNEC [MIG	6.04214	3.55396	0.0004
EG [MIG	5.02012	2.59110	0.0096
EG [ND	4.99101	2.57452	0.0100

[= non-homogeneously effect

Discussion:

The estimations yield the statistically significant findings.

1. Migration helps in reduction of carbon emission with the protection of environment quality, migration can result in form of positive environmental outcomes such as improved land redistribution and efficient land use practices (Aguilar & Støen 2012). Migration can be used as adaptive strategy to protect the degradation of the environment. The efficiency of the adaptation strategy to mitigate the environmental hazards can be achieved through household resources and social network (Groth *et al*., 2020).

2. Natural disasters in the form of earthquake, volcanic eruptions and droughts have significant negative substantial long term impact on the environmental quality Faradiba, F. (2024). Environmental degradation across air and water with the disturbance in ecosystem is the result of the natural disaster Kamboj *et al*., 2020). Natural disaster deteriorate the environmental quality maintaining institutions which are responsible to control the environment quality (Khurana *et al*., 2022) this impact of the natural disaster cab be mitigated by the quality infrastructure development which significantly reduces the cost generated by the natural disaster to the region Taghizadeh *et al*., 2019)

3. Tourism can lead to the protection of the environment quality through the provision of the awareness and conservation by funding. The economic opportunity of the tourism can compel the authorities to protect the environment by investing in the infrastructure and gain from tourism industry which ultimately improves environment quality (Ghulam *et al*., 2013). This process demands the involvement of the local communities to protect their culture and environment in the development of the infrastructure (Jalloh 2021). Eco cultural and quality tourism can provide a basic framework for the protection of environment from development of infrastructure (George *et al*., 2013).

4. Renewable energy such as hydropower and biofuel results in the form of habitat loss, wildlife extinction and biodiversity loss which shows the degradation of the environmental

quality due to the renewable energy use Pratiwi, S., & Juerges, N. (2020). Use of renewable energy increases the demand of the rare earth minerals which results in environmental as well as socio economic challenges to the region Ebube, O. F., & Akan, E. E. (2021). Waste created from use of renewable energy such as chemical substances are harmful for the environment if they are not handled properly (Balladares *et al*., 2022). This negative impact can be mitigated by strong regulatory policies and recycling technologies (Pratiwi & Juerges 2020).

5. Environmental quality depends on the income level of the region justifying the environmental kuznets curve hypothesis (Verbeke & De Clercq 2002). Economic growth leads to increase the environmental degradation but the effective policies can improve the economic growth along the environmental quality Ikefuji, M., & Horii, R. (2007). Economic growth increases the emission in the air polluting the environment to a certain level of income, cost and benefits associated with the economic growth defines the improvement and degradation of the environment (Burnett 2009). Economic growth is fueled by the environmental degradation which results in undesirable outcome and compensated welfare (Wagner 2004).

According to the discussion the environmental quality should be protected along the migration and tourism. The impact of the natural disaster should be made limited by the adaptation strategies, and use of renewable energy should be efficient to avoid its negative impact on environment. Economic growth must be assisted by the other approaches such as trade openness to reduce the burden of production which leads to pollution of the environment.

Conclusion and policy implication:

The increasing environmental degradation because of the migration, Natural disaster, tourism, renewable energy use and economic growth increase the threat of the climate change and global warming. This study aims to find the impact of migration, Natural disaster, tourism, renewable energy use and economic growth on environmental degradation in panel of 6 selected south Asian economies by using data from 1998-2022. The study used ARDL to find the long term impact of the stated variables on the environmental outcome. The results showed that migration and tourism improve the environmental quality while the Natural disaster, renewable energy use and economic growth degrade the environmental quality. The study represents the complex relationship among the variables. The migration carries the potential to positively impact the environmental quality by the reallocation of population and resources. Natural disaster contributes to the carbon emission and causes the environmental quality to degrade with the occurrence of such events in long run. However, tourism improves environmental quality and sustainable tourism practices can help to conserve the environment in long run. Unexpectedly renewable energy consumption decreases the environmental quality which may be due to the cost associated with the infrastructure development

of the renewable energy deployment. Lastly the economic growth does cause decrease in environmental quality as expected which is possibly because of the increase in production for economic expansion.

Based on the results the following policy implications have been suggested for the selected south Asian economies.

1. Migration has increased globally due to high social and economic demands, contributing to the global environmental threats. Social and economic situation can be the key factors to increase in the migration, which ultimately pressurize the resources to associate the migrants. Additionally, the planned urbanization and development of infrastructure can help to mitigate the negative environmental impact of the migration.

2. Natural disasters mostly caused by the climate change are increasing over the time period as the climate change is getting worse. Natural disaster poses a significant threat to each sector of the region. Recovery plans and forestation to conserve the soil can restore the quality of the environment.

3. tourism is a great source for the people to live their lives at best. Tourist involves the great income opportunity for the people and help to make the people basic source of earning. Tourism has the great potential to improve the environment if handed sustainably, policy makers should ensure the environmental conversation with the provision of attraction for the tourist which can provide the great income opportunity as well as environmental protection to the region. Similarly, the encouraging the investors in green infrastructure for the tourism can be helpful to achieve the environmental protection target of the region.

4. Use of renewable energy is critical to meet the economic needs of the region as compare to the fossil fuel because fossil fuel carries a great threat to the environmental quality of the region as compare to the renewable energy. Although renewable energy is also a reason of the emission of the gases up to some extent. The policy makers should be concern about the improvement of the efficiency of renewable energy and environmental performance by using the technologies. The awareness of the people to minimum energy use can also be helpful to achieve the protection of the environment.

5. The economic growth is essential to meet the increasing demand of the increasing population in the region. The economic growth deteriorates the environment quality as more production leads to the emissions. similarly cleaner production process and sustainable technologies can help the policy makers to achieve the environment protection targets.

6. The different polices are needed to improve the environmental quality in long term and short term. In short terms the immediate negative impact of the migration and tourism are needed to address while the renewable energy use and economic growth are positively associated in the short term which does not bothers the policy makers. In long term the policies should strengthen the positive impact of the migration and tourism on environmental quality mean while the negative impact of natural disaster and economic growth are to be harnessed in long run.

The suggested polices are the proposal to protect the environmental quality from the negative impact of the natural disaster, renewable energy and economic growth. Multi-faceted approach to balance the benefit of the migration and tourism is needed.

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