

# Disaster Preparedness Leading to Positive Impacts on Economic Indicators

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## **Abstract.**

*The objective of the research is to measure the impacts of natural disaster in terms of no. of deaths, no. of disasters and economic damages on economic indicators like agricultural and forestry growth, industry including construction growth, migration, export etc. as percentage of GDP. As these indicators will depend upon, how the preparedness and mitigation measures are being taken.*

*A simulation model is constructed using ARDL (Auto Regressive Distributed Lag), VECM (Vector error correction model) and VAR (Vector Auto Regression) considering the impacts of natural disaster events like flood, cyclone, wild fire, etc. on economic indicators like agricultural and forestry growth, industry including construction growth, migration, export etc. as percentage of GDP.*

*Under the different scenarios, simulation results have been analysed and it is observed in over-all perspective that Implementing disaster preparedness and mitigation strategies can significantly reduce indirect economic losses caused by floods and cyclones, fostering economic resilience within communities.*

**Keywords:** *Natural disasters, Simulation, Economic indicators, Resilience, vulnerability.*

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## **INTRODUCTION:**

Disaster preparedness contributes to saving lives and reducing economic losses. A key element of any effective disaster risk reduction strategy, preparedness can build and strengthen early warning systems, enhance public awareness and response capacities as well as improve understanding of roles and responsibilities in the event of a disaster.

The concept of disaster preparedness encompasses measures aimed at enhancing life safety when a disaster occurs, such as protective actions during an earthquake, hazardous materials spill, or terrorist attack. It also includes actions designed to enhance the ability to undertake emergency actions in order to protect property and contain disaster damage and disruption, as well as the ability to engage in post-disaster restoration and early recovery activities (J Sutton et al).

Disaster preparedness consists of a set of measures undertaken by governments, organizations, communities, or individuals to better respond and cope with the immediate aftermath of a disaster, whether it is man-made or caused by natural hazards. The objective is to reduce the loss of life and livelihoods. Simple initiatives can go a long way, for instance, training for search and rescue, establishing early warning systems, developing contingency plans, or stockpiling equipment and supplies. Disaster risk reduction (DRR) and preparedness play an important role in building the resilience of communities.

Organizational activities which ensure that the systems, procedures, and resources required to confront a natural disaster are available to provide timely assistance to those affected, using existing mechanisms wherever possible (for example, training, awareness raising, establishment of disaster plans, evacuation plans, pre-positioning of stocks, early warning mechanisms, and strengthening of indigenous knowledge). Measures taken before disasters which intend to reduce or eliminate their impact on society and the environment. These measures reduce the physical vulnerability of existing infrastructures or of vulnerable sites which directly endanger the populations (for example, retrofitting of buildings and reinforce 'lifeline' infrastructure).

Activities conceived to ensure permanent protection against disasters. These include engineering, physical protection measures, legislative measures for the control of land use, and codes of construction. These activities reduce the physical vulnerability and/or exposure to risks through infrastructures (for example, dams, flood barriers, and building of refuges) and through improvement of existing infrastructures (for example, restoring original flood patterns of rivers to avoid excessive floods downstream) and sustainable development practices (for example, no deforestation in upstream areas and active reforestation).

Disaster preparedness has been identified with planning, resource identification, warning systems, throwing and simulations, and other predistister actions intended to improve the safety and effectiveness

of community response to disaster. Despite its acknowledged importance, little attention has been given to clarifying the conceptualization and strengthening the measurement of preparedness (David F. Gillespie et al).

### LITERATURE REVIEW:

In a study, the impact of disasters on economic growth by examining at the firm level the relationship between natural disasters and business activities in the short run. Understanding firm responses to natural disasters helps design efficient responses to natural disasters. The impacts of natural disasters on the macro-economy largely materialize through their effects on firms through the generation of jobs and income. Natural disasters are exogenous shocks that directly affect firms' production and demand for production inputs, and induce resource reallocation in the process of firm exit, entry, and the expansion and contraction of existing firms (Fujin Zhou et al).

Research describes the direct and dynamic effects of the earthquake disaster on economic growth using panel data from 181 county-level cities from 2003 to 2013. In addition, based on fiscal expenditure data, national rescue variables are developed and used to analyze the effects of disaster aid on economic growth in the affected areas and to identify the specific methods used to administer this aid (Renjie Zhao et al).

In study of meta-analysis, specifically taken into account a number of issues. First, tried to discover if there exists a genuine relationship between natural disasters and growth. Second, analysed whether studies suffer from a potential publication bias, i.e. whether results published provide a biased distribution of effects found, because there may be a tendency not to publish results that show no significant results. Next, analyzed the potential impact of the study design on the results reported. In particular, study focuses on the impact of differences between studies regarding country samples, time periods, and estimation methods (Jeroen Klomp et al).

One study focuses on cross-country data from 168 countries during 1990-2016. The random effect specification is found to be the most appropriate for capturing these interrelationships between natural disaster loss, economic development, socio-economic and geographic factors since the random effect model considers both country and time characteristics. The results show that higher income can lower disaster loss (Karnjana Songwathana)

One study analyzed the economic and disaster data from 1970 through 2010 to investigate the impact of disasters on country/region-level economic growth and leveraged a random parameter modeling approach to develop the growth-econometrics model that identifies risk factors significantly influencing the country/region-level economic growth in the face of natural hazard-induced disasters (Sayanti Mukherjee et al).

### METHODOLOGY

#### Data and Methodology:

A simulation model is constructed using ARDL (Auto Regressive Distributed Lag), VECM (Vector error correction model) and VAR (Vector Auto Regression) considering the impacts of natural disaster events like flood, cyclone, wild fire, etc. on economic indicators like agricultural and forestry growth, industry including construction growth, migration, export etc. as percentage of GDP.

The data have been considered from EM Dat and World Development Indicators in modelling.

Autoregressive Distributed Lag Models (ARDL) model plays a vital role when comes to a need to analyze an economic scenario. In an economy, change in any economic variables may bring change in another economic variable beyond time. This change in a variable is not reflected immediately, but it distributes over future periods. Not only macroeconomic variables, but other variables such as loss or profit earned by a firm in a year can also affect the brand image of an organization over the period.

The below function represents the lag effect of a variable on other variables and its own lags as well  $Y_t = f(X_t, X_{t-1}, X_{t-2}, \dots)$ , where,  $t-i$  represents the number of lags.

In order to determine, the dynamic influence of a variable on other variables, there occurs multiple distributed lag models such as polynomial, geometric and other distributed lag models in econometrics. However, the ARDL model addresses the distributed lag problem more efficiently than these models.

#### ARDL Model:

An ARDL (Autoregressive-distributed lag) is a parsimonious infinite lag-distributed model. The term "autoregressive" shows that along with getting explained by the  $x_t$ ,  $y_t$  also gets explained by its own lag also. Equation of ARDL(m,n) is as follows:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \dots + \beta_p y_{t-m} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \dots + \alpha_q x_{t-n} + \varepsilon_t$$

Here,  $m$  and  $n$  are the numbers of years for lag,  $\epsilon_t$  is the disturbance terms and  $\beta_i$ 's are coefficients for short-run and  $\alpha_i$ 's are coefficients for long-run relationship.

Lacks in distributed lag models other than ARDL

Collinearity emerges as a major issue while dealing with any econometrics model. The finite distributed lag model requires dealing with the collinearity issue by choosing an optimal lag length. The polynomial distributed lag (PDL) removes the collinearity by making the lag weights lie on its curve.

In the infinite lag model, there are infinite numbers of parameters to estimate which is complex to solve. This model solves the issue of specifying a certain length of lags. On the contrary, it requires imposing a structure on the lag lengths by making the model non-linear. In addition to this, the Geometric model works as an infinite lag-distributed model. This model puts the successive lag weights in this model to decline geometrically.

On the other hand, the ARDL model addresses the issue of collinearity by allowing the lag of the dependent variable in the model with other independent variables and their lags.

#### Assumptions for ARDL Model

- The absence of autocorrelation is the very first requirement of ARDL. The model requires that the error terms should have no autocorrelation with each other.
- There should not occur any heteroscedasticity in the data. In simple terms, the variance and mean should remain constant throughout the model.
- The data should follow a normal distribution.
- Data should have stationary either on  $I(0)$  or  $I(1)$  or on both. In addition to this, if any of the variables in the data has stationary at  $I(2)$ , ARDL Model cannot run.

#### VAR (Vector Auto Regression)

First, what is Vector Autoregression (VAR) and when to use it?

Vector Autoregression (VAR) is a multivariate forecasting algorithm that is used when two or more time series influence each other.

That means, the basic requirements in order to use VAR are:

1. we need at least two time series (variables)
2. The time series should influence each other.

It is called 'Autoregressive' because It is considered as an Autoregressive model as, each variable (Time Series) is modeled as a function of the past values that is the predictors are nothing but the lags (time delayed value) of the series.

Now, how is VAR different from other Autoregressive models like AR, ARMA or ARIMA?

The primary difference is those models are uni-directional, where, the predictors influence the Y and not vice-versa. Whereas, Vector Auto Regression (VAR) is bi-directional. That is, the variables influence each other.

A typical AR (p) model equation looks something like this:

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \dots + \beta_p Y_{t-p} + \epsilon_t$$

Where  $\alpha$  is the intercept, a constant and  $\beta_1, \beta_2$  till  $\beta_p$  are the coefficients of the lags of Y till order p.

Order 'p' means, up to p-lags of Y is used and they are the predictors in the equation. The  $\epsilon_{\{t\}}$  is the error, which is considered as white noise.

Alright. So, how does a VAR model's formula look like?

In the VAR model, each variable is modeled as a linear combination of past values of itself and the past values of other variables in the system. Since you have multiple time series that influence each other, it is modeled as a system of equations with one equation per variable (time series).

That is, if you have 5 time series that influence each other, we will have a system of 5 equations.

Therefore, the equation is exactly framed as below :

Let's suppose, you have two variables (Time series) Y1 and Y2, and you need to forecast the values of these variables at time (t).

To calculate Y1(t), VAR will use the past values of both Y1 as well as Y2. Likewise, to compute Y2(t), the past values of both Y1 and Y2 be used.

For example, the system of equations for a VAR(1) model with two time series (variables 'Y1' and 'Y2') is as follows:

$$Y_{1,t} = \alpha_1 + \beta_{11} Y_{1,t-1} + \beta_{12} Y_{2,t-1} + \epsilon_{1,t}$$

$$Y_{2,t} = \alpha_2 + \beta_{21} Y_{1,t-1} + \beta_{22} Y_{2,t-1} + \epsilon_{2,t}$$

Where,  $Y_{1,t-1}$  and  $Y_{2,t-1}$  are the first lag of time series  $Y_1$  and  $Y_2$  respectively.

The above equation is referred to as a VAR(1) model, because, each equation is of order 1, that is, it contains up to one lag of each of the predictors ( $Y_1$  and  $Y_2$ ).

Since the  $Y$  terms in the equations are interrelated, the  $Y$ 's are considered as endogenous variables, rather than as exogenous predictors.

Likewise, the second order VAR(2) model for two variables would include up to two lags for each variable ( $Y_1$  and  $Y_2$ ).

$$Y_{1,t} = \alpha_1 + \beta_{11,1}Y_{1,t-1} + \beta_{12,1}Y_{2,t-1} + \beta_{11,2}Y_{1,t-2} + \beta_{12,2}Y_{2,t-2} + \epsilon_{1,t}$$

$$Y_{2,t} = \alpha_2 + \beta_{21,1}Y_{1,t-1} + \beta_{22,1}Y_{2,t-1} + \beta_{21,2}Y_{1,t-2} + \beta_{22,2}Y_{2,t-2} + \epsilon_{2,t}$$

Can you imagine what a second order VAR(2) model with three variables ( $Y_1$ ,  $Y_2$  and  $Y_3$ ) would look like?

$$Y_{1,t} = \alpha_1 + \beta_{11,1}Y_{1,t-1} + \beta_{12,1}Y_{2,t-1} + \beta_{13,1}Y_{3,t-1} + \beta_{11,2}Y_{1,t-2} + \beta_{12,2}Y_{2,t-2} + \beta_{13,2}Y_{3,t-2} + \epsilon_{1,t}$$

$$Y_{2,t} = \alpha_2 + \beta_{21,1}Y_{1,t-1} + \beta_{22,1}Y_{2,t-1} + \beta_{23,1}Y_{3,t-1} + \beta_{21,2}Y_{1,t-2} + \beta_{22,2}Y_{2,t-2} + \beta_{23,2}Y_{3,t-2} + \epsilon_{2,t}$$

$$Y_{3,t} = \alpha_3 + \beta_{31,1}Y_{1,t-1} + \beta_{32,1}Y_{2,t-1} + \beta_{33,1}Y_{3,t-1} + \beta_{31,2}Y_{1,t-2} + \beta_{32,2}Y_{2,t-2} + \beta_{33,2}Y_{3,t-2} + \epsilon_{3,t}$$

As we increase the number of time series (variables) in the model the system of equations become larger

## RESULTS AND DISCUSSIONS:

Effect of Human deaths, No. of disaster in a year on Agriculture\_\_forestry\_\_and\_fishing\_\_value\_added\_\_\_\_of\_gdp\_:

Table 1.1 : ARDL Model

Dependent Variable: AGRICULTURE\_\_FORESTRY\_\_AND\_FISHING\_\_V  
ALUE\_ADDED\_\_\_\_OF\_GDP\_1

Method: ARDL

Date: 07/20/24 Time: 17:20

Sample (adjusted): 1979 2022

Included observations: 44 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (3 lags, automatic): DAMAGE\_000\_US\_\$\_  
HUMAN\_DEATHS1 NO\_OF\_DISASTER

Fixed regressors: C

Number of models evaluated: 256

Selected Model: ARDL(3, 1, 2, 1)

Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
AGRICULTURE__FORESTRY__AN D_FISHING__VALUE_ADDED____ OF_GDP_1(-1)	0.468136	0.136595	3.427174	0.0017
AGRICULTURE__FORESTRY__AN D_FISHING__VALUE_ADDED____ OF_GDP_1(-2)	0.148149	0.152021	0.974530	0.3369
AGRICULTURE__FORESTRY__AN D_FISHING__VALUE_ADDED____ OF_GDP_1(-3)	0.354450	0.128028	2.768523	0.0092
DAMAGE_000_US_\$_ DAMAGE_000_US_\$_(-1)	1.69E-09 4.28E-08	1.65E-08 1.61E-08	0.102303 2.660540	0.9191 0.0120
HUMAN_DEATHS1 HUMAN_DEATHS1(-1)	-1.20E-05 -8.46E-05	2.48E-05 2.31E-05	-0.484959 -3.665433	0.6309 0.0009
HUMAN_DEATHS1(-2)	-6.33E-05	2.35E-05	-2.698345	0.0109
NO_OF_DISASTER NO_OF_DISASTER(-1)	-0.035246 0.020521	0.011538 0.012403	-3.054761 1.654466	0.0044 0.1075
C	0.946975	0.730635	1.296098	0.2039

R-squared	0.992365	Mean dependent var	23.15122
Adjusted R-squared	0.990052	S.D. dependent var	6.198224
S.E. of regression	0.618220	Akaike info criterion	2.088373
Sum squared resid	12.61247	Schwarz criterion	2.534421
Log likelihood	-34.94422	Hannan-Quinn criter.	2.253789
F-statistic	428.9319	Durbin-Watson stat	1.807581
Prob(F-statistic)	0.000000		

\*Note: p-values and any subsequent tests do not account for model selection.

Table 1.2 :Wald Test:

Coefficient	Value	SE
C(1)	0.468136	0.136595
C(2)	0.148149	0.152021
C(3)	0.354450	0.128028

	Value	df	Probability
F-statistic	869.7326	(3, 33)	0.0000
Chi-square	2609.198	3	0.0000

C(4)	1.69E-09	1.65E-08
C(5)	4.28E-08	1.61E-08

F-statistic	3.551288	(2, 33)	0.0401
Chi-square	7.102575	2	0.0287

C(6)	-1.20E-05	2.48E-05
C(7)	-8.46E-05	2.31E-05
C(8)	-6.33E-05	2.35E-05

F-statistic	6.585428	(3, 33)	0.0013
Chi-square	19.75628	3	0.0002

C(9)	-0.035246	0.011538
C(10)	0.020521	0.012403

F-statistic	4.743396	(2, 33)	0.0155
Chi-square	9.486792	2	0.0087

Based on unit rate test, all the variables either are stationary at level or I difference. The agricultural, forestry and fishing value added to GDP itself the lagged period, two and three lag periods has a positive influence on current period as per wald test. Damages at lag influence agricultural, forestry and fishing value added to GDP positively, however damages at current period and lag jointly influence agricultural, forestry and fishing value added to GDP positively. Human deaths at lagged period and two lag period influence agricultural, forestry and fishing value added to GDP negatively, also influence jointly negatively. No. of disaster at current period influence negatively, also influence jointly.

Adjusted R<sup>2</sup> is 0.99 and F value 428.93(p=0) is significant. Durbin Watson value is 1.80, indicates that it is free from serial correlation.

Histogram normality test found satisfactory

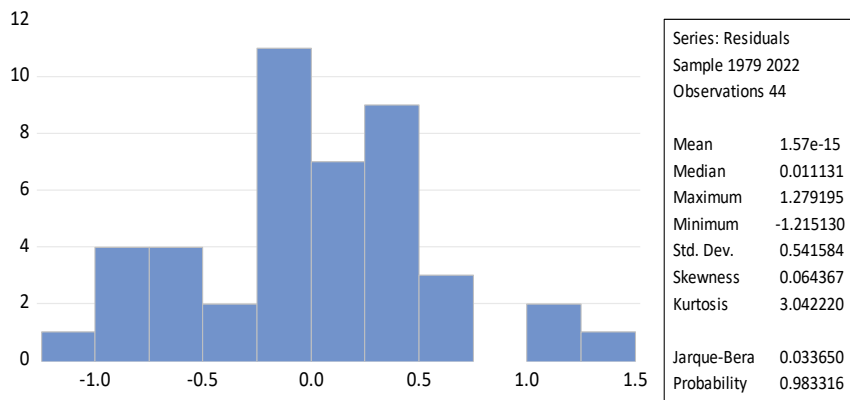


Fig.1.1 Histogram normality test found satisfactory

Table 1.3 :Breusch-Godfrey Serial Correlation LM Test: Found satisfactory  
 Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.214148	Prob. F(2,31)	0.8084
Obs*R-squared	0.599620	Prob. Chi-Square(2)	0.7410

Table 1.4 :Heteroscedasticity Test: Breusch-Pagan-Godfrey: Found satisfactory  
 Null hypothesis: Homoskedasticity

F-statistic	1.587676	Prob. F(10,33)	0.1539
Obs*R-squared	14.29263	Prob. Chi-Square(10)	0.1601
Scaled explained SS	8.209320	Prob. Chi-Square(10)	0.6084

Table	1.5	:ARDL	Bound	Test:
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	10.71355	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

The calculated F value is 10.71 which is above the upper and lower bounds test. The critical value of upper bound is 4.66 and lower bound is 3.67 at 5% significance level. This means that Null hypothesis of a cointegrating relationship can be rejected which indicates that agricultural, forestry and fishing value added to GDP is cointegrating with damages, no. of human deaths and no. of disasters. So there exists a long run relationship among variables.

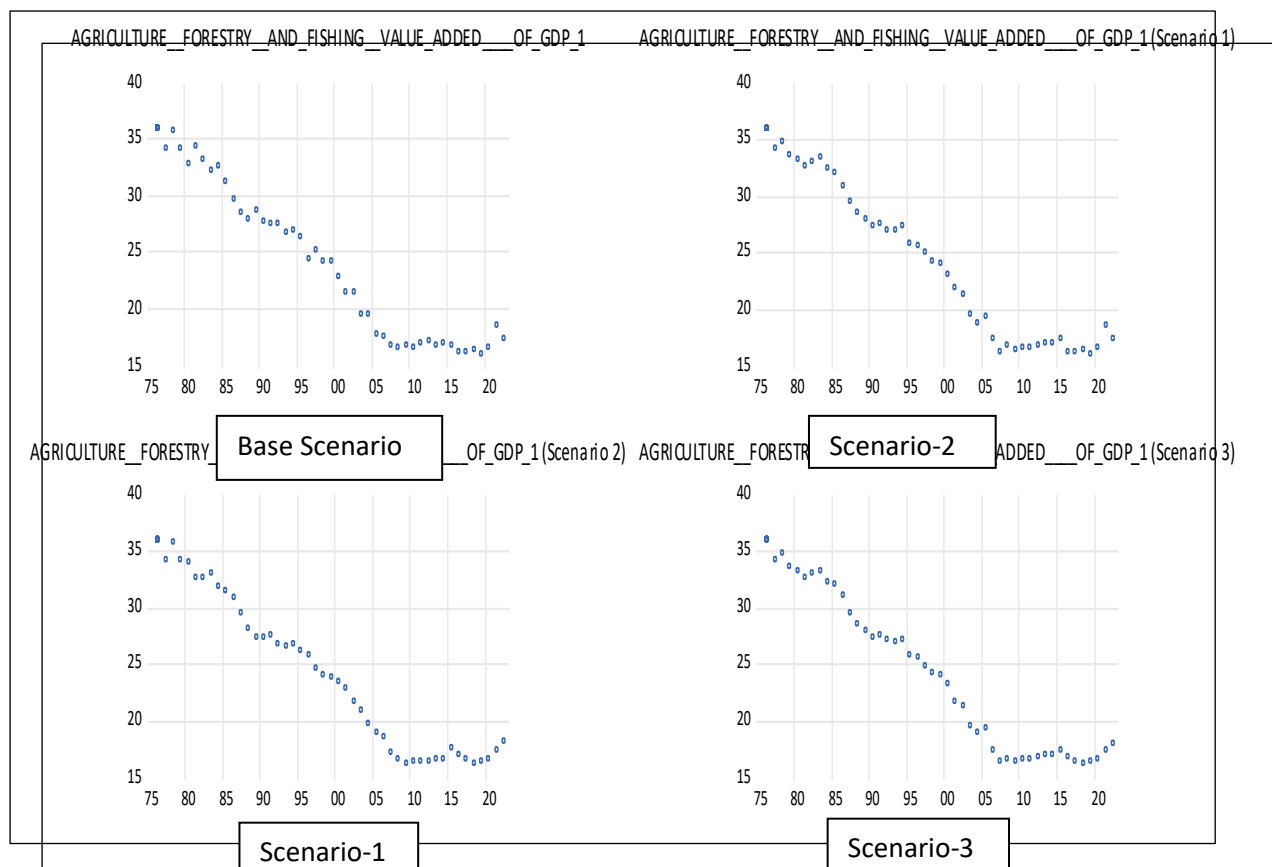
Variable	Coefficient	Std. Error	t-Statistic	Prob.
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CointEq(-1)*	-0.029266	0.003776	-7.749892	0.0000
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The CointEq(-1)\* is negative with a coefficient estimate of -0.029266. This implies that the speed of adjustment towards long run equilibrium is 103% as system corrects its previous period disequilibrium

at a speed of 103% within one period of time. The t-statistics-7.7498, and the coefficient is significant. Agricultural, forestry and fishing value added to GDP itself at current and one period lag(-0.50,-0.35), no. of disasters(-0.035) have negative and significant impact on Agricultural, forestry and fishing value added to GDP, human deaths at one period lag(0.0000633) has positive and significant impact on Agricultural, forestry and fishing value added to GDP in long run.

### 3.1.1 Simulation results of the model:



**Scenario 1**, when damages is reduced by 50% from 2015 to 2022, the effect is not visible as the value of coefficient is very low. As the economic benefits of the new roads would lead to increase in agricultural production, change in the crop pattern, reduction in the transport costs, creation of new employment opportunities in other that agricultural sector, increase in the land prices, better climate for setting up cottage and agro-Industries.

**Scenario 2**, when no. of human deaths is reduced by 50% from 2015 to 2022, the Agricultural, forestry and fishing value added to GDP becomes 17.4 to 18.2. Agriculture is also influenced by human factors like market, labour and political aid. If there is availability of cheap labour, then labour intensive crops are grown. Places near markets grow perishable goods. Government aid in agriculture is an important factor too. Especially, during disasters, low income group is suffered being most vulnerable.

**Scenario 3**, when no. of disasters is reduced by 50% from 2015 to 2022, the Agricultural, forestry and fishing value added to GDP becomes 17.4 to 18.1. India on average suffers an economic loss of US\$7 billion each year because of natural disaster, according to the United Nations. Reduced disaster frequency has direct bearing on Agricultural, forestry and fishing.

The simulation results are in consonance with the constructed model for Agricultural, forestry and fishing value added to GDP.

### Effect of Human deaths, No. of disaster in a year on Industry including construction growth:

Table 1.6 : Dependent Variable:

INDUSTRY\_INCLUDING\_CONSTRUCTION\_GROWTH1

Method: ARDL

Date: 07/21/24 Time: 11:56  
Sample (adjusted): 1978 2022  
Included observations: 45 after adjustments  
Maximum dependent lags: 1 (Automatic selection)  
Model selection method: Akaike info criterion (AIC)  
Dynamic regressors (3 lags, automatic): DAMAGE\_000\_US\_\$\_  
HUMAN\_DEATHS1 NO\_OF\_DISASTER  
Fixed regressors: C  
Number of models evaluated: 64  
Selected Model: ARDL(1, 2, 2, 1)  
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
INDUSTRY_INCLUDING_CONST				
RUCTION_GROWTH1(-1)	0.932934	0.064208	14.52987	0.0000
DAMAGE_000_US_\$_	-2.02E-08	1.54E-08	-1.305036	0.2004
DAMAGE_000_US_\$_(-1)	-1.79E-08	1.57E-08	-1.138989	0.2624
DAMAGE_000_US_\$_(-2)	3.45E-08	1.61E-08	2.137256	0.0396
HUMAN_DEATHS1	-8.81E-06	2.35E-05	-0.374512	0.7103
HUMAN_DEATHS1(-1)	5.61E-05	2.37E-05	2.363540	0.0238
HUMAN_DEATHS1(-2)	3.03E-05	2.17E-05	1.393712	0.1722
NO_OF_DISASTER	0.024981	0.011305	2.209849	0.0337
NO_OF_DISASTER(-1)	-0.026570	0.011886	-2.235474	0.0319
C	1.579048	1.737996	0.908545	0.3698
R-squared	0.894226	Mean dependent var	27.44735	
Adjusted R-squared	0.867027	S.D. dependent var	1.733155	
S.E. of regression	0.632004	Akaike info criterion	2.113287	
Sum squared resid	13.98000	Schwarz criterion	2.514767	
Log likelihood	-37.54895	Hannan-Quinn criter.	2.262955	
F-statistic	32.87705	Durbin-Watson stat	1.864480	
Prob(F-statistic)	0.000000			

\*Note: p-values and any subsequent tests do not account for model selection.

**Table 1.7**

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.466801	(3, 35)	0.0783
Chi-square	7.400404	3	0.0602

**Table 1.8**

Null Hypothesis: C(2)=C(3)=C(4)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(2)	-2.02E-08	1.54E-08
C(3)	-1.79E-08	1.57E-08
C(4)	3.45E-08	1.61E-08

Restrictions are linear in coefficients.

**Table 1.9**

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.432252	(3, 35)	0.0814
Chi-square	7.296757	3	0.0630

Null Hypothesis:  $C(5)=C(6)=C(7)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(5)	-8.81E-06
C(6)	5.61E-05
C(7)	3.03E-05

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.281476	(2, 35)	0.0494
Chi-square	6.562953	2	0.0376

Null Hypothesis:  $C(8)=C(9)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(8)	0.024981
C(9)	-0.026570

Based on unit rate test, all the variables either are stationary at level or I difference. The industry including construction growth itself the lagged period, has a positive influence on current period. Damages at current period, one lag and two lag period jointly do not influence industry including construction growth, however damages at lag two period influence industry including construction growth positively. Human deaths at lagged period, one period lag and two lag period do not influence industry including construction growth, however human death at one lag period alone influence industry including construction growth positively. No. of disaster at current period influence positively and one lag period negatively, also influence jointly.

Adjusted  $R^2$  is 0.867 and F value 32.87( $p=0$ ) is significant. Durbin Watson value is 1.86, indicates that it is free from serial correlation.

Histogram normality test found satisfactory

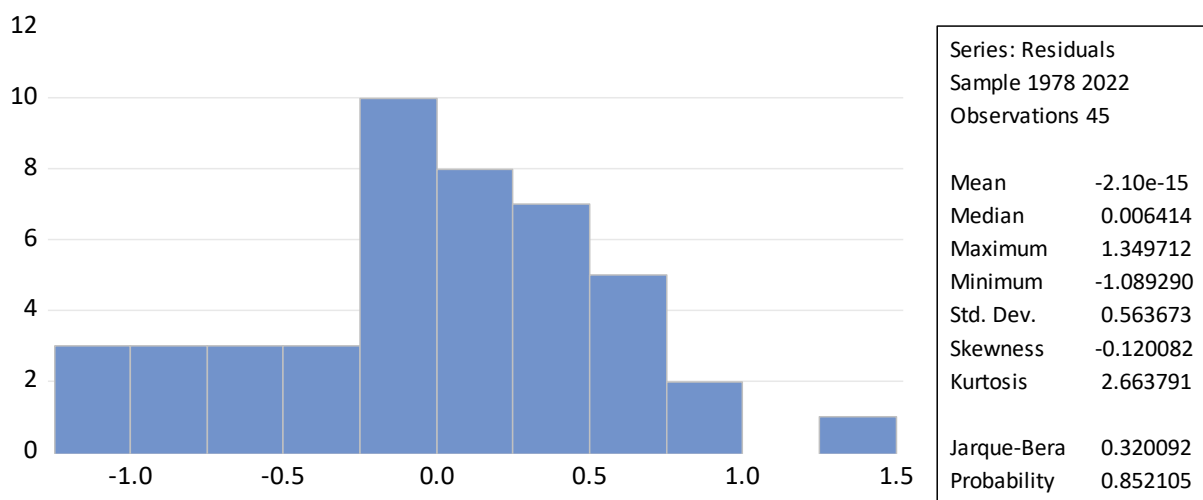


Fig.1.2 Histogram normality test found satisfactory

**Table 2.0**

Breusch-Godfrey Serial Correlation LM Test:  
 Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.547620	Prob. F(2,33)	0.5835
Obs*R-squared	1.445534	Prob. Chi-Square(2)	0.4854

**Table 2.1**

Heteroskedasticity Test: Breusch-Pagan-Godfrey  
 Null hypothesis: Homoskedasticity

F-statistic	2.678097	Prob. F(9,35)	0.0176
Obs*R-squared	18.35155	Prob. Chi-Square(9)	0.0313
Scaled explained SS	9.235331	Prob. Chi-Square(9)	0.4158

Table 2.2 : ARDL Bound Test:

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	1.469186	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Finite Sample: n=45				
Actual Sample Size	45	10%	2.56	3.428
		5%	3.078	4.022
		1%	4.27	5.412

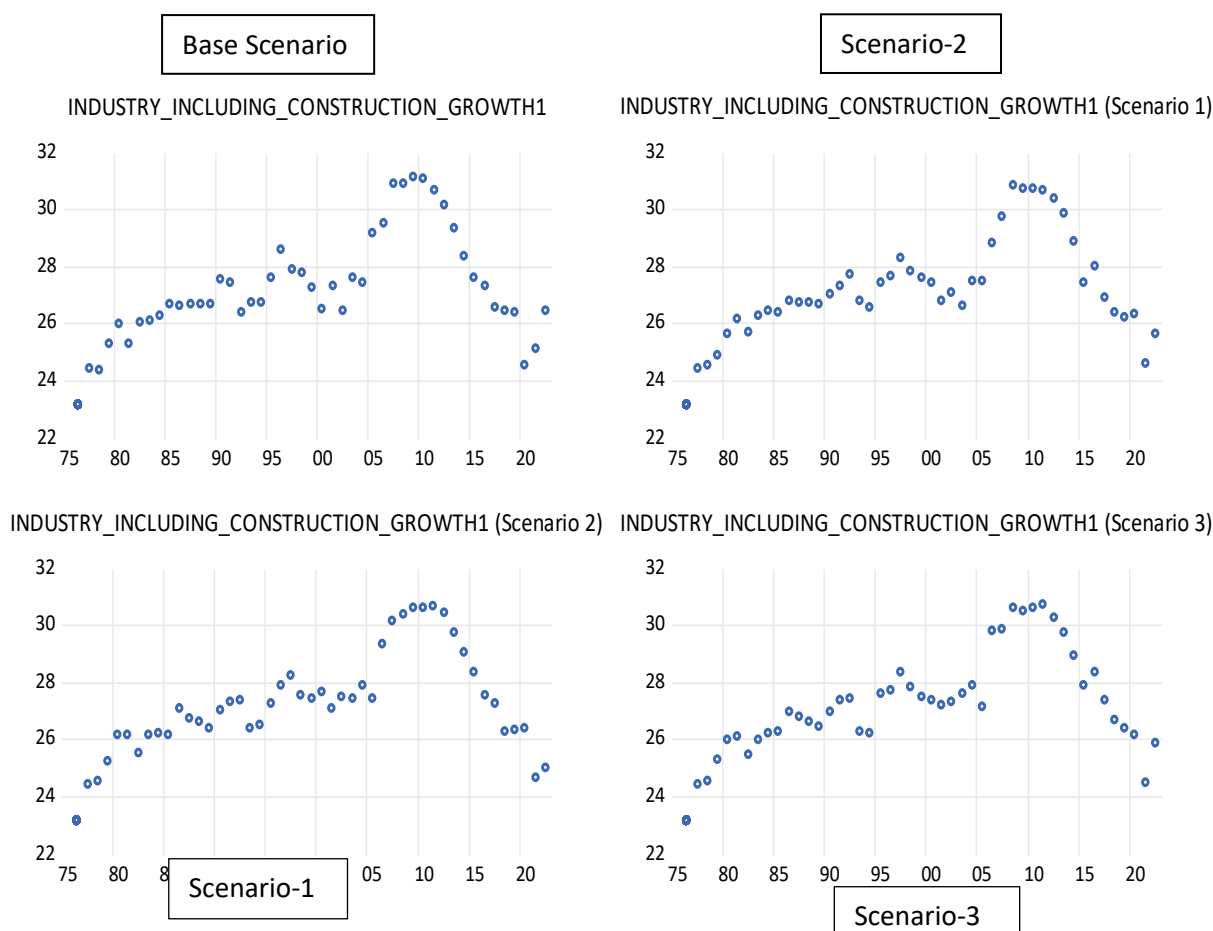
The calculated F value is 1.49 which is below the upper and lower bounds test. The critical value of upper bound is 3.67 and lower bound is 2.79 at 5% significance level. This means that Null hypothesis of as cointegrating relationship can be rejected which indicates that industry including construction growth is cointegrating with damages, no. of human deaths and no. of disasters. So there exists a long run relationship among variables.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
----------	-------------	------------	-------------	-------

CointEq(-1)*	-0.067066	0.023441	-2.861026	0.0071
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The CointEq(-1)\* is negative with a coefficient estimate of -0.067066. This implies that the speed of adjustment towards long run equilibrium is 107% as system corrects its previous period disequilibrium at a speed of 107% within one period of time. The t-statistics -2.861026, and the coefficient is significant. Damage at one period lag (-3.45E-08) has long run negative influence on industry including construction growth. No. of disaster at current period (0.2489) is significant and positive influence on industry including construction growth in long run.

### Simulation results of the model:



**Scenario 1**, when human death is reduced by 50% from 2015 to 2022, the industry including construction growth is also reduced as human death at one period lag influence growth positively.

**Scenario 2**, when damage is reduced by 50% from 2015 to 2022, the industry including construction growth is also reduced as damage at two lag period influence industry including construction growth positively. However, in long run industry including construction growth will increase due to decrease in damage.

**Scenario 3**, when no. of disasters is reduced by 50% from 2015 to 2022, industry including construction growth becomes 26.5 to 25.9. As no. of disaster at current period influence growth positively and one lag

period negatively, therefore due to mixed effect a slight reduction is seen. However, the growth will be positively influenced by no. of disasters in long run.

In fact, the natural disasters emerge as opportunities for Industry including construction.

The simulation results are in consonance with the constructed model industry including construction growth.

**Effect of Human deaths, No. of disaster in a year on Export of Goods and Services as % of GDP**

**Table 2.3**

Dependent Variable: EXPORT\_OF\_GOODS\_AND\_SERVICES\_AS\_\_\_  
OF\_GDP1

Method: ARDL

Date: 07/23/24 Time: 13:35

Sample (adjusted): 1979 2022

Included observations: 44 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): DAMAGE\_000\_US\_\$\_  
HUMAN\_DEATHS1 NO\_OF\_DISASTER

Fixed regressors: C

Number of models evaluated: 500

Selected Model: ARDL(1, 1, 0, 4)

Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
<b>EXPORT_OF_GOODS_AND_SERV</b>				
ICES_AS___OF_GDP1(-1)	0.946147	0.037206	25.43022	0.0000
DAMAGE_000_US_\$_	1.24E-08	3.32E-08	0.372672	0.7117
DAMAGE_000_US_\$_(-1)	-4.61E-08	3.33E-08	-1.384645	0.1752
HUMAN_DEATHS1	-8.30E-08	5.13E-05	-0.001618	0.9987
NO_OF_DISASTER	-0.020377	0.023975	-0.849924	0.4013
NO_OF_DISASTER(-1)	-0.003619	0.024933	-0.145152	0.8854
NO_OF_DISASTER(-2)	0.006494	0.025163	0.258084	0.7979
NO_OF_DISASTER(-3)	-0.013297	0.024358	-0.545915	0.5887
NO_OF_DISASTER(-4)	0.076770	0.023616	3.250718	0.0026
C	-0.114115	0.719701	-0.158559	0.8750
R-squared	0.971505	Mean dependent var	13.77190	
Adjusted R-squared	0.963963	S.D. dependent var	6.760140	
S.E. of regression	1.283309	Akaike info criterion	3.533477	
Sum squared resid	55.99395	Schwarz criterion	3.938974	
Log likelihood	-67.73649	Hannan-Quinn criter.	3.683855	
F-statistic	128.8013	Durbin-Watson stat	2.135342	
Prob(F-statistic)	0.000000			

\*Note: p-values and any subsequent tests do not account for model selection.

**Table 2.4**

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	0.985504	(2, 34)	0.3837
Chi-square	1.971008	2	0.3733

Null Hypothesis:  $C(2)=C(3)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(2)	1.24E-08
C(3)	-4.61E-08

Restrictions are linear in coefficients.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.378780	(4, 34)	0.0197
Chi-square	13.51512	4	0.0090

Null Hypothesis:  $C(6)=C(7)=C(8)=C(9)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(6)	-0.003619
C(7)	0.006494
C(8)	-0.013297
C(9)	0.076770

Based on unit rate test, all the variables either are stationary at level or I difference. Export of Goods and Services as % of GDP itself the lagged period, has a positive influence on current period. No. of disasters at one lag, two lag, three lag and four lag period jointly influence Export of Goods and Services as % of GDP, however at fourth lag period alone influence Export of Goods and Services as % of GDP positively.

Adjusted  $R^2$  is 0.97 and F value 128.8( $p=0$ ) is significant. Durbin Watson value is 2.13, indicates that it is with slight serial correlation.

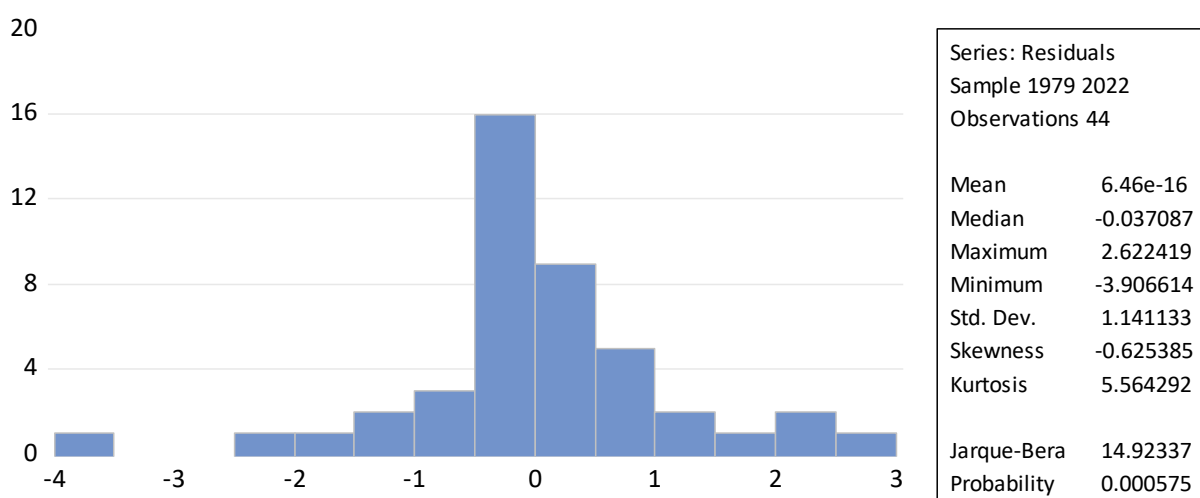


Fig.1.3 Histogram normality test found satisfactory

Table 2.5

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.282714	Prob. F(2,32)	0.7556
Obs*R-squared	0.763965	Prob. Chi-Square(2)	0.6825

Table 2.6  
Heteroskedasticity Test: Breusch-Pagan-Godfrey  
Null hypothesis: Homoskedasticity

F-statistic	1.660497	Prob. F(9,34)	0.1376
Obs*R-squared	13.43475	Prob. Chi-Square(9)	0.1439
Scaled explained SS	18.30735	Prob. Chi-Square(9)	0.0318

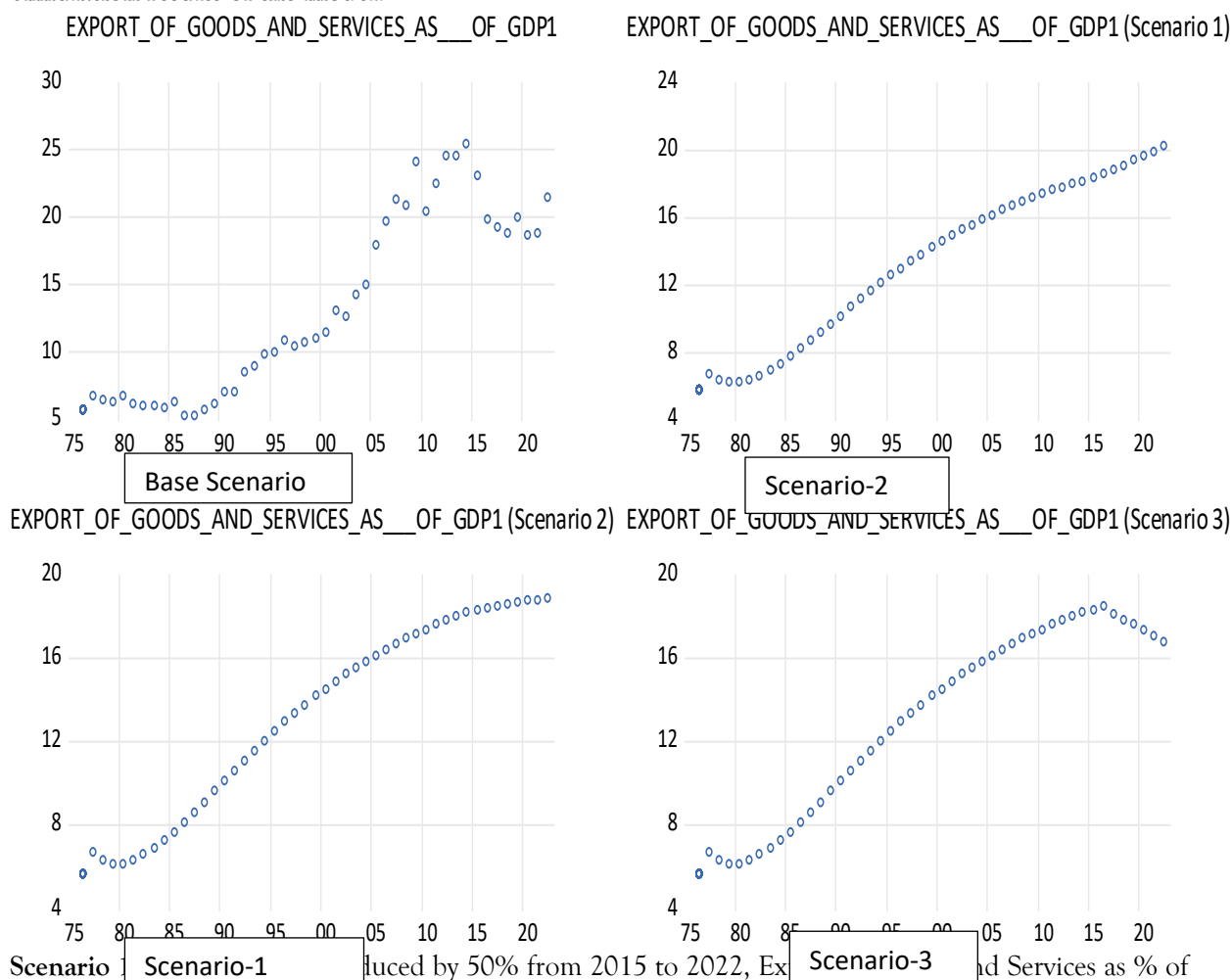
Table	2.7	:ARDL		Bound	Test:
F-Bounds Test		Null Hypothesis:	No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)	
Asymptotic: n=1000					
F-statistic	2.371007	10%	2.37	3.2	
k	3	5%	2.79	3.67	
		2.5%	3.15	4.08	
		1%	3.65	4.66	
Finite Sample: n=45					
Actual Sample Size	44	10%	2.56	3.428	
		5%	3.078	4.022	
		1%	4.27	5.412	
Finite Sample: n=40					
		10%	2.592	3.454	
		5%	3.1	4.088	
		1%	4.31	5.544	

The calculated F value is 2.37 which is below the upper and lower bounds test. The critical value of upper bound is 3.67 and lower bound is 2.79 at 5% significance level. This means that Null hypothesis of a cointegrating relationship can be rejected which indicates that Export of Goods and Services as % of GDP is cointegrating with damages, no. of human deaths and no. of disasters. So there exists a long run relationship among variables.

Variable	Coefficient	Std. Error	t-Statistic	Prob.	
CointEq(-1)*	.067066	0.023441	-2.861026	0.0071	The CointEq(-1)* is negative with a coefficient estimate of -0.067066. This implies that the speed of adjustment towards long run equilibrium is 107% as system corrects its previous period disequilibrium at a speed of 107% within one period of time. The t-statistics-2.861026, and the coefficient

is significant. No. of disasters at lag period 1,2 and 3(-0.069,-0.063 and -0.0767) has long run negative influence on Export of Goods and Services as % of GDP.

**Simulation results of the model:**



**Scenario 1** when no. of death is reduced by 50% from 2015 to 2022, Export of Goods and Services as % of GDP is not influenced either in short run or long run.

**Scenario 2**, when no. of death is reduced by 50% from 2015 to 2022, Export of Goods and Services as % of GDP is not influenced either in short run or long run.

**Scenario 3**, when no. of disasters is reduced by 50% from 2015 to 2022, Export of Goods and Services as % of GDP becomes 21.4 to 18.6 in short run as no. of disasters influence Export of Goods and Services as % of GDP positively. However, no. of disasters at lag one, two and three period influence Export of Goods and Services as % of GDP negatively, therefore Export of Goods and Services as % of GDP will increase with reduction of no. of disasters. Although, Findings on the effects of natural disasters on trade are more ambiguous, but at least it can be concluded that exports seem to be affected negatively by the occurrence and severity of disasters in the exporting country in long run as established by the model. The result suggests that the long-term effect of climate disasters increasing overall international trade is due to increasing imports in developing countries (Fengyu Liu et al.) The impact of climate disaster on international trade: Evidence from developed and developing countries, Journal of Environmental Management, Volume 342,2023 118308, ISSN 0301-4797.

The simulation results are in consonance with the constructed model for Export of Goods and Services as % of GDP.

**Effect of Human deaths, No. of disaster in a year on Remittance:**

**Table 2.8**

Dependent Variable: REMITTANCE\_CURRENT\_US\_\$\_1

Method: ARDL

Date: 07/23/24 Time: 16:15

Sample (adjusted): 1979 2022

Included observations: 44 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)  
Dynamic regressors (4 lags, automatic): DAMAGE\_000\_US\_\$\_  
HUMAN\_DEATHS1 NO\_OF\_DISASTER  
Fixed regressors: C  
Number of models evaluated: 500  
Selected Model: ARDL(3, 4, 0, 4)  
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
REMITTANCE_CURRENT_US_\$_1(-1)	1.220030	0.153179	7.964716	0.0000
REMITTANCE_CURRENT_US_\$_1(-2)	-0.380086	0.224800	-1.690773	0.1016
REMITTANCE_CURRENT_US_\$_1(-3)	0.208408	0.146153	1.425960	0.1646
DAMAGE_000_US_\$_	-83.35013	71.25970	-1.169667	0.2517
DAMAGE_000_US_\$_(-1)	-126.2424	74.82515	-1.687165	0.1023
DAMAGE_000_US_\$_(-2)	-80.18270	77.08264	-1.040217	0.3068
DAMAGE_000_US_\$_(-3)	-134.3026	89.85334	-1.494687	0.1458
DAMAGE_000_US_\$_(-4)	175.5717	95.69622	1.834678	0.0768
HUMAN_DEATHS1	-122563.7	98228.03	-1.247747	0.2221
NO_OF_DISASTER	-1.85E+08	47134124	-3.931582	0.0005
NO_OF_DISASTER(-1)	35312039	53456507	0.660575	0.5141
NO_OF_DISASTER(-2)	31971770	53775703	0.594539	0.5568
NO_OF_DISASTER(-3)	39286828	49971081	0.786191	0.4381
NO_OF_DISASTER(-4)	1.31E+08	48965953	2.668795	0.0123
C	1.18E+09	1.32E+09	0.894043	0.3787
R-squared	0.995618	Mean dependent var	2.78E+10	
Adjusted R-squared	0.993503	S.D. dependent var	2.99E+10	
S.E. of regression	2.41E+09	Akaike info criterion	46.31083	
Sum squared resid	1.69E+20	Schwarz criterion	46.91908	
Log likelihood	-1003.838	Hannan-Quinn criter.	46.53640	
F-statistic	470.6715	Durbin-Watson stat	1.859666	
Prob(F-statistic)	0.000000			

\*Note: p-values and any subsequent tests do not account for model selection.

**Table 2.9**

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	658.7153	(3, 29)	0.0000
Chi-square	1976.146	3	0.0000

Null Hypothesis: C(1)=C(2)=C(3)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	1.220030	0.153179
C(2)	-0.380086	0.224800
C(3)	0.208408	0.146153

Restrictions are linear in coefficients.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.945016	(5, 29)	0.0286
Chi-square	14.72508	5	0.0116

Null Hypothesis:  $C(4)=C(5)=C(6)=C(7)=C(8)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(4)	-83.35013 71.25970
C(5)	-126.2424 74.82515
C(6)	-80.18270 77.08264
C(7)	-134.3026 89.85334
C(8)	175.5717 95.69622

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	5.754495	(5, 29)	0.0008
Chi-square	28.77247	5	0.0000

Null Hypothesis:  $C(10)=C(11)=C(12)=C(13)=C(14)=0$

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(10)	-1.85E+08 47134124
C(11)	35312039 53456507
C(12)	31971770 53775703
C(13)	39286828 49971081
C(14)	1.31E+08 48965953

Based on unit rate test, all the variables either are stationary at level or I difference. Remittance itself the lagged period, has a positive influence on current period. Also, Remittance at lag one, lag two and lag three period jointly influence. Damages at current period and lag(1-4) period jointly influence. No. of disasters at current period and lag(1-4) period jointly influence.

Adjusted  $R^2$  is 0.99 and F value 470.67(p=0) is significant. Durbin Watson value is 1.85, indicates that it is free from serial correlation.

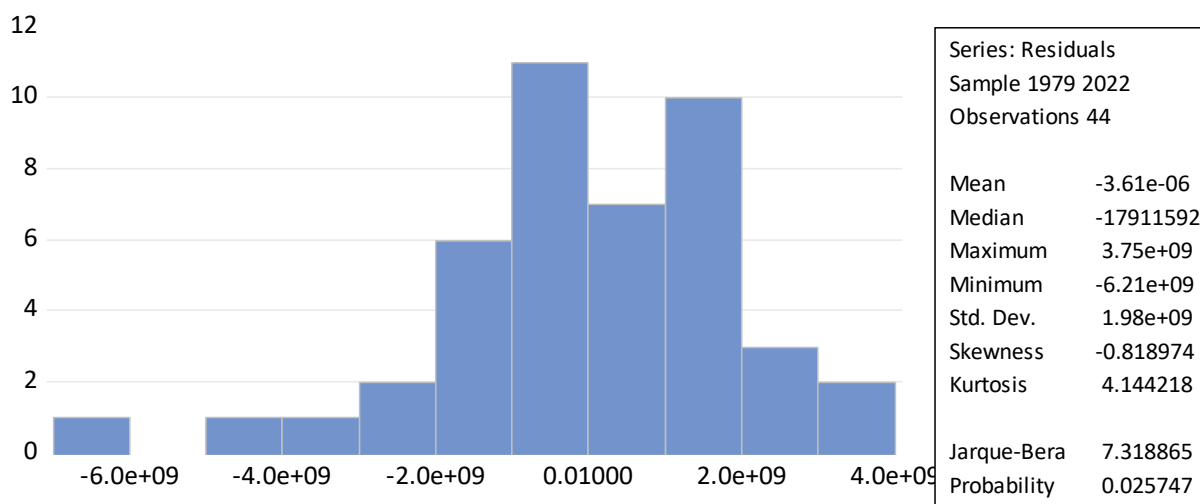


Fig.1.4 Histogram normality test found satisfactory

Histogram Normality test indicates that data are not perfectly normal.

**Table 3.0**

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.651487	Prob. F(2,27)	0.2106
Obs*R-squared	4.795928	Prob. Chi-Square(2)	0.0909

LM test indicates that data is free from serial correlation at 5% significance level.

**Table 3.1**

Heteroskedasticity Test: Breusch-Pagan-Godfrey

Null hypothesis: Homoskedasticity

F-statistic	1.489669	Prob. F(14,29)	0.1770
Obs*R-squared	18.40596	Prob. Chi-Square(14)	0.1889
Scaled explained SS	12.56990	Prob. Chi-Square(14)	0.5606

Results show that there is Homoscedasticity in data set.

Table 3.2: ARDL Bound Test

Null Hypothesis: No levels relationship

F-Bounds Test	Value	Signif.	I(0)	I(1)
---------------	-------	---------	------	------

Asymptotic: n=1000				
F-statistic	4.228296	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Finite Sample: n=44				
Actual Sample Size	44	10%	2.56	3.428
		5%	3.078	4.022

1%	4.27	5.412
	Finite Sample: n=40	
10%	2.592	3.454
5%	3.1	4.088
1%	4.31	5.544

The calculated F value is 4.22 which is above the upper and lower bounds test. The critical value of upper bound is 3.67 and lower bound is 2.79 at 5% significance level. This means that Null hypothesis of a cointegrating relationship can be rejected which indicates that Remittance is cointegrating with damages, no. of human deaths and no. of disasters. So there exists a long run relationship among variables.

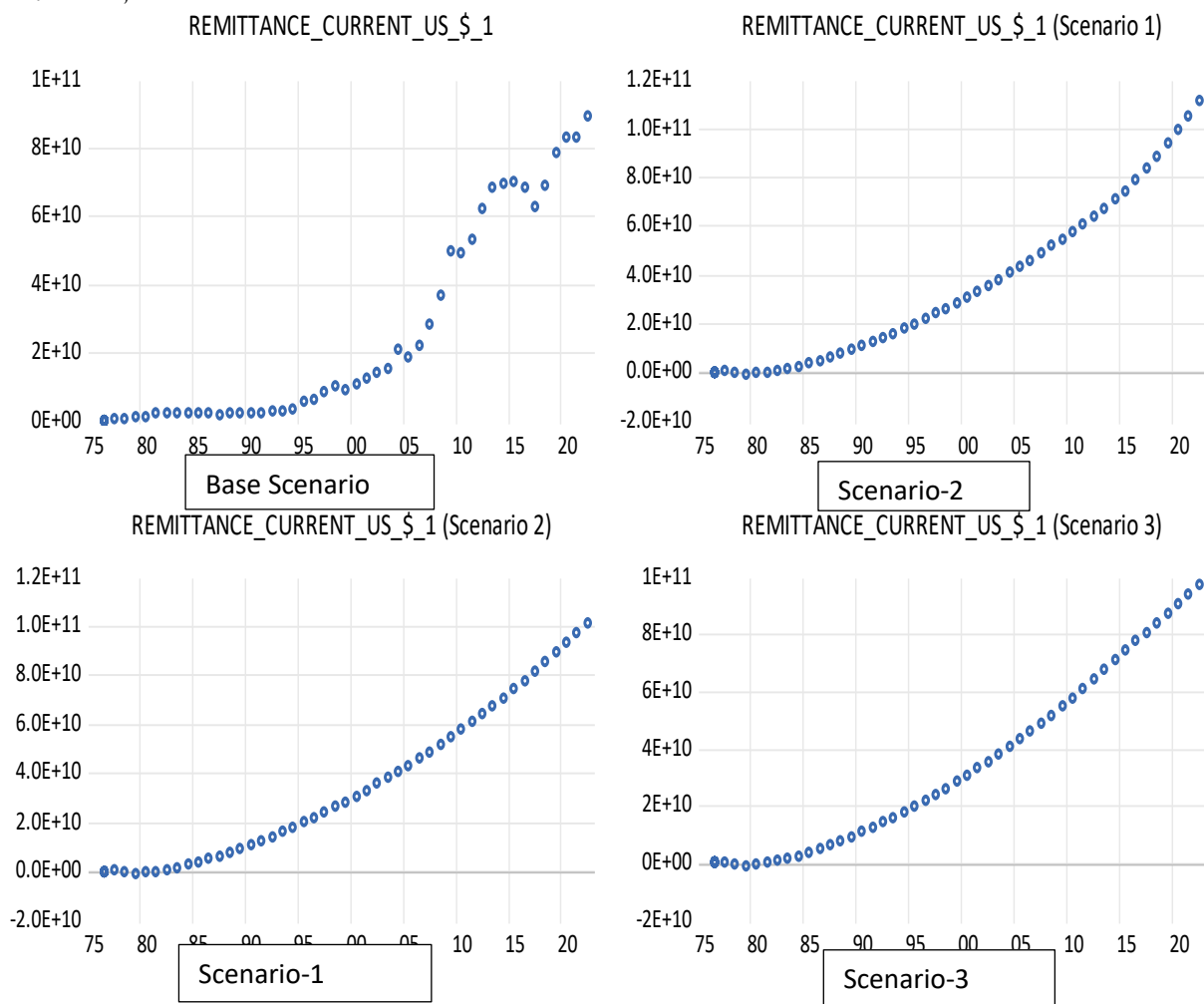
Variable                      Coefficient Std. Error    t-Statistic    Prob.

CointEq(-1)\*                0.048352   0.009858    4.904849    0.0000

1.31E+08) has long run negative influence on Remittance.

The CointEq(-1)\* is negative with a coefficient estimate of -

0.048352. This implies that the speed of adjustment towards long run equilibrium is 105% as system corrects its previous period disequilibrium at a speed of 105% within one period of time. The t-statistics 4.904849, and the coefficient is significant. Damages at lag three period (-175.57) has long run negative influence on Remittance. No. of disasters at current period and lag(1-3) period(-1.85E+08,-2.02E+08,-1.71E+08,-Simulation results of the model:



**Scenario 1**, when damage is reduced by 50% from 2015 to 2022, Remittance increases from US\$8.94E+10 to 1.21E+11US \$ in long run. As, damage influence remittance negatively. As 75% of remittances are used to put food on the table and cover medical expenses. Under the reduced economic damage of a country, most of the economic indicators will improve upon resulting into decrease of remittance use on regular expenses. Than the increase in remittance may play important role in economic development of any country particularly under developed and developing countries because it an important and stable source of foreign exchange reserve and external finance.

According to the World bank, India has the largest emigrant population and is the top remittance country. In 2023, remittance was 120 Billion US\$.

During budget session in parliament on 23.07.2024, Finance Minister Smt.Niramala Sitaraman stated that “The outlook for remittance in India for 2024 is strong, with expectation that remittance growth will moderate to 3.7 %, taking.... levels to USD 124” the Economic survey tabled in Parliament by Finance Minister.

It is advocated here that proclamation of remittance to the tune of 124 USD is totally subjected to reduction of economic damages by 50% in India by way of implementing disaster preparedness in holistic manner across the country, providing ample opportunities, good economic condition, perfect supply and demand, controlled inflation, adequate infrastructure etc..

**Scenario 2**, The no. of death has no influence on remittance either in short run or long run.

**Scenario 3**, No. of disasters at current period and lag(1-3) period(-1.85E+08,-2.02E+08,-1.71E+08,-1.31E+08) has also long run negative influence on Remittance when no. of disasters is reduced by 50% from 2015 to 2022, Remittance has been found to be increased from US\$8.94E+10 to 9.76E+10 US \$ in long run.

As the no. of disasters, its intensity and affected areas depend upon no. of climatic factors, which are changing quite frequently. Climate change and its consequences are chaotic and has become a global issue. Every country is putting their best efforts to cope up with the emerged situation but how much success is obtained has always been the debatable issue. In this study, the no. of disasters reduced by 50% just to check the simulated results, which is just a hypothetical approach. Only the damage control is in our hand if we have fool proof disaster management plans, disaster preparedness and mitigation strategies. Therefore, only scenario 1 is worth to consider for this model

The simulation results are in consonance with the constructed model for Remittance.

**Effect of Human deaths, No. of disaster in a year on Migration:**

**Table 3.3**

Dependent Variable: MIGRATION1

Method: ARDL

Date: 07/22/24 Time: 22:20

Sample (adjusted): 1979 2022

Included observations: 44 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): DAMAGE\_000\_US\_\$\_  
HUMAN\_DEATHS1 NO\_OF\_DISASTER

Fixed regressors: C

Number of models evaluated: 500

Selected Model: ARDL(1, 4, 0, 1)

Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
MIGRATION1(-1)	0.760962	0.104802	7.260979	0.0000
DAMAGE_000_US_\$				
-	-0.006146	0.004023	-1.527915	0.1358
DAMAGE_000_US_\$				
_(1)	0.006108	0.004141	1.474938	0.1494
DAMAGE_000_US_\$				
_(2)	-0.004484	0.004215	-1.063978	0.2948

DAMAGE_000_US_\$				
_(3)	0.005587	0.004990	1.119553	0.2708
DAMAGE_000_US_\$				
_(4)	-0.009653	0.005113	-1.887925	0.0676
HUMAN_DEATHS1	-3.154480	6.586867	-0.478904	0.6351
NO_OF_DISASTER	5509.745	3002.352	1.835143	0.0752
NO_OF_DISASTER(-				
1)	-6666.068	2784.634	-2.393876	0.0223
C	32137.38	87728.98	0.366326	0.7164
<hr/>				
R-squared	0.677689	Mean dependent var	-198831.4	
Adjusted R-squared	0.592371	S.D. dependent var	258611.4	
S.E. of regression	165112.5	Akaike info criterion	27.06336	
Sum squared resid	9.27E+11	Schwarz criterion	27.46886	
Log likelihood	-585.3939	Hannan-Quinn criter.	27.21374	
F-statistic	7.943127	Durbin-Watson stat	2.014365	
Prob(F-statistic)	0.000003			

**Table 3.4**

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	1.782917	(5, 34)	0.1428
Chi-square	8.914584	5	0.1125

Null Hypothesis: C(2)=C(3)=C(4)=C(5)=C(6)=0

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(2)	-0.006146
C(3)	0.006108
C(4)	-0.004484
C(5)	0.005587
C(6)	-0.009653

Restrictions are linear in coefficients.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.033340	(2, 34)	0.0614
Chi-square	6.066679	2	0.0482

Null Hypothesis: C(8)=C(9)=0

Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(8)	5509.745
C(9)	-6666.068

Based on unit rate test, all the variables either are stationary at level or I difference. Migration itself the lagged period, has a positive influence on current period. Damages at four lag period influence migration negatively. However. Damage at lag period(1-4) jointly do not influence migration. No. of disasters at current period and lag(1) period influence positively and negatively respectively. Also, no. of disaster at current period and one lag period jointly influence migration.

Adjusted R<sup>2</sup> is 0.68, reasonably good and F value 7.94(p=0) is significant. Durbin Watson value is 2.01, indicates that it is free from serial correlation.

Table 3.5 :ARDL Bound Test:

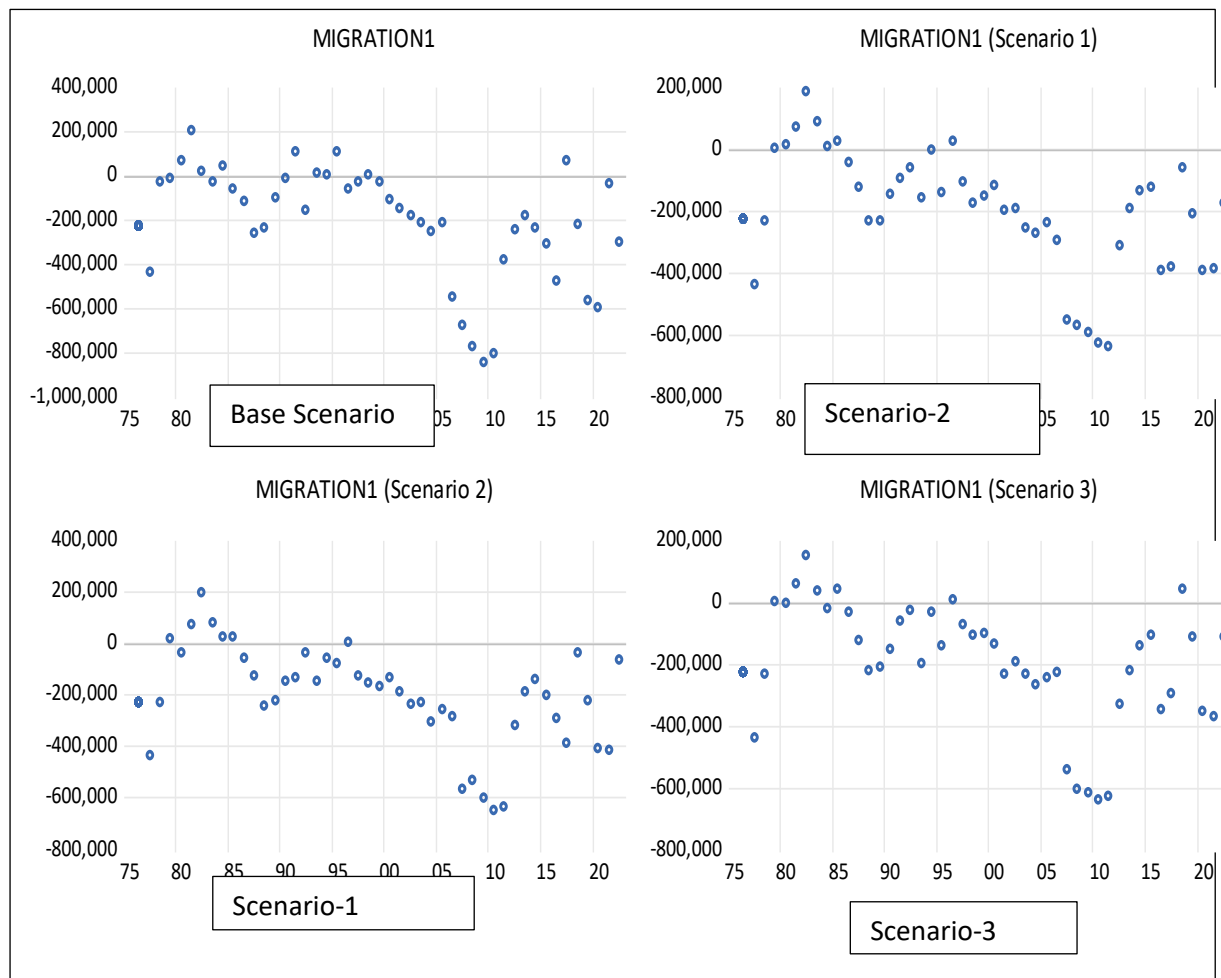
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	2.157246	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Finite Sample: n=50				
Actual Sample Size	46	10%	2.538	3.398
		5%	3.048	4.002
		1%	4.188	5.328
Finite Sample: n=45				
		10%	2.56	3.428
		5%	3.078	4.022
		1%	4.27	5.412

The calculated F value is 2.15 which is below the upper and lower bounds test. The critical value of upper bound is 3.2 and lower bound is 2.37 at 10% significance level. This means that Null hypothesis of as contigrating relationship can be rejected which indicates that Remittance is contigrating with damages, no. of human deaths and no. of disasters. So there exists a long run relationship among variables.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-0.312785	0.090806	-3.444539	0.0014

The CointEq(-1)\* is negative with a coefficient estimate of -0.312785. This implies that the speed of adjustment towards long run equilibrium is 131% as system corrects its previous period disequilibrium at a speed of 131% within one period of time. The t-statistics -3.444539, and the coefficient is significant. No. of disaster at current period (5533.56) has long run positive influence on migration.

**Simulation results of the model:**



**Scenario 1**, Although the coefficient of no. of human deaths is not significant, still it is observed that it influences migration negatively.

**Scenario 2**, Reduction in damage may be understood in terms of wellbeing of a country i.e. Govt. of that country is in a position of providing ample opportunities, good economic condition, perfect supply and demand, adequate infrastructure etc. these factors diminish migration of a country.

**Scenario 3**, No. of disasters at current period and lag(1) period(5509.04,5533.56) has also short as well as long run positive influence on migration when no. of disasters is reduced by 50% from 2015 to 2022, Migration value moves towards positive indicating suppression in migration. Under the situation of increase frequency of disasters, if consequential damage is not controlled that will lead to increase in migration.

The simulation results are in consonance with the constructed model for Remittance

**Effect of Human deaths, No. of disaster in a year on Migration:**

Table 3.6

Dependent Variable: GDP\_CURRENT\_US\_\$1

Method: ARDL

Date: 07/25/24 Time: 11:36

Sample (adjusted): 1978 2022

Included observations: 45 after adjustments

Maximum dependent lags: 4 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Dynamic regressors (4 lags, automatic): DAMAGE\_000\_US\_\$\_

HUMAN\_DEATHS1 NO\_OF\_DISASTER

Fixed regressors: C

Number of models evaluated: 500

Selected Model: ARDL(2, 1, 0, 1)

Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP_CURRENT_US_\$1 (-1)	0.664322	0.160663	4.134868	0.0002
GDP_CURRENT_US_\$1 (-2)	0.471098	0.172628	2.728973	0.0097
DAMAGE_000_US_\$_ DAMAGE_000_US_\$_(-1)	-6001.491	2558.465	-2.345739	0.0245
HUMAN_DEATHS1	-7043.921	2614.068	-2.694621	0.0105
NO_OF_DISASTER	1525725.	3359682.	0.454128	0.6524
NO_OF_DISASTER(-1)	-1.33E+09	1.60E+09	-0.827112	0.4135
C	2.24E+09	1.47E+09	1.520744	0.1368
	2.75E+09	4.65E+10	0.059073	0.9532
R-squared	0.991619	Mean dependent var	9.39E+11	
Adjusted R-squared	0.990033	S.D. dependent var	9.10E+11	
S.E. of regression	9.08E+10	Akaike info criterion	53.46215	
Sum squared resid	3.05E+23	Schwarz criterion	53.78334	
Log likelihood	-1194.898	Hannan-Quinn criter.	53.58189	
F-statistic	625.3773	Durbin-Watson stat	2.174218	
Prob(F-statistic)	0.000000			

Table3.7

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	1126.522	(2, 37)	0.0000
Chi-square	2253.043	2	0.0000

Null Hypothesis: C(1)=C(2)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.664322	0.160663
C(2)	0.471098	0.172628

Restrictions are linear in coefficients.

Wald Test:

Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	5.607825	(2, 37)	0.0075
Chi-square	11.21565	2	0.0037

Null Hypothesis: C(3)=C(4)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
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C(3)	-6001.491	2558.465
C(4)	-7043.921	2614.068

Wald Test:  
 Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	1.166273	(2, 37)	0.3227
Chi-square	2.332545	2	0.3115

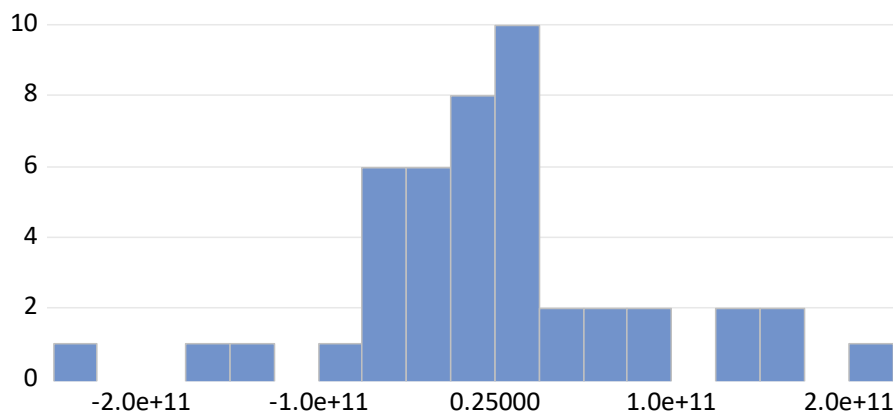
Null Hypothesis: C(6)=C(7)=0  
 Null Hypothesis Summary:

Normalized Restriction (= 0) Value	Std. Err.
C(6)	-1.33E+09 1.60E+09
C(7)	2.24E+09 1.47E+09

Based on unit rate test, all the variables either are stationary at level or I difference. GDP itself the lagged period and one lag period has a positive influence on current period. Damages at current period and one lag influence GDP positively. However. There is no influence of human deaths and disaster frequency in short run

Adjusted R<sup>2</sup> is 0.99, reasonably good and F value 625.37(p=0) is significant. Durbin Watson value is 2.17, indicates that there may be slight serial correlation.

12



Series: Residuals	
Sample	1978 2022
Observations	45
Mean	-1.36e-06
Median	-1.16e+09
Maximum	2.05e+11
Minimum	-2.32e+11
Std. Dev.	8.33e+10
Skewness	0.119668
Kurtosis	4.095886
Jarque-Bera	2.359215
Probability	0.307399

Fig.1.4 Histogram normality test found satisfactory

Breusch-Godfrey Serial Correlation LM Test:  
 Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.518173	Prob. F(2,35)	0.2332
Obs*R-squared	3.592236	Prob. Chi-Square(2)	0.1659

Heteroskedasticity Test: Breusch-Pagan-Godfrey  
 Null hypothesis: Homoskedasticity

F-statistic	3.005133	Prob. F(7,37)	0.0133
Obs*R-squared	16.31088	Prob. Chi-Square(7)	0.0224
Scaled explained SS	17.06910	Prob. Chi-Square(7)	0.0170

Table 3.8 :ARDL Bound Test:

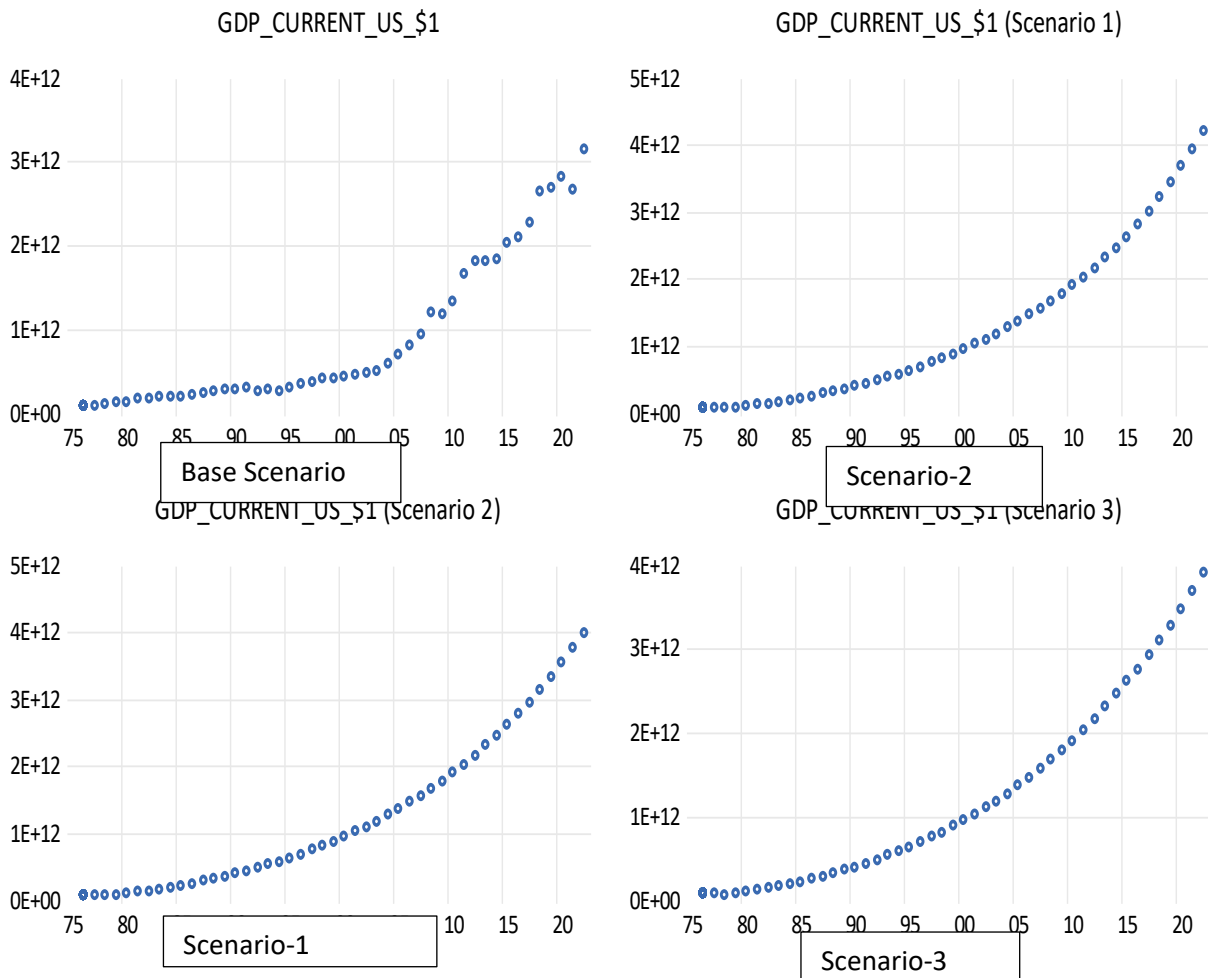
F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	8.990536	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Finite Sample: n=45				
Actual Sample Size	45	10%	2.56	3.428
		5%	3.078	4.022
		1%	4.27	5.412

The calculated F value is 8.99 which is above the upper and lower bounds test. The critical value of upper bound is 3.67 and lower bound is 2.79 at 5% significance level. This means that Null hypothesis of as cointegrating relationship can be rejected which indicates that GDP is cointegrating with damages, no. of human deaths and no. of disasters. So there exists a long run relationship among variables.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	0.135419	0.019187	7.057792	0.0000

The CointEq(-1)\* is positive with a coefficient estimate of 0.135419. Coefficient is positive but significant this implies that the speed of non-adjustment towards long run equilibrium is 113% as system does not correct its previous period disequilibrium at a speed of 113% within one period of time. The t-statistics 7.057792, and the coefficient is significant. GDP at one period lag(-0.471), Damage(-6001.49) and No. of disaster (-1.33E+09) have long run negative influence on GDP.

**Simulation results of the model:**



**Scenario 1,** As the damage influence GDP negatively, hence here we can see that a reduction in damage by 50% boosts the GDP by 33.3%. Therefore, the prime concern for any Government should be to reduce the economic losses emerged as a result of natural disasters. Not only direct losses need to be taken care of rather indirect losses too, as these are quite significant, even some times exceeds the direct losses.

**Scenario 2,** Although, the impact of human death is not directly influencing GDP as a whole but it has significant impact in other sectors like Agricultural, as observed in this research. Therefore, cumulative effect shows that if no. of human deaths is reduced by 50% , there are chances of getting boost in over-all GDP.

**Scenario 3,** As the no. of disasters has influence GDP negatively in long run, hence here we can see that a reduction in no. of disaster by 50% boosts the GDP by 23.6%. The frequency of disasters, intensity and particular area affected is not predictable under the faster changes in climate. Therefore, the prime concern for any Government should be to implement disaster preparedness plans of international level, well defined policies should be on place, identification of vulnerable areas and providing required infrastructure to combat with any eventuality.

The results of the above simulation models clearly indicate that there is a significant impact of natural disaster on economic activities in short as well as long run. Therefore disaster preparedness and mitigation strategies can play very important role in reducing the economic losses.

Implementing disaster preparedness and mitigation strategies can significantly reduce indirect economic losses caused by floods and cyclones, fostering economic resilience within communities.

## CONCLUSION:

With the reduction in no. of Human deaths and impact of no. of disaster by way of providing resilience infrastructure, the Agriculture\_\_forestry\_\_and\_fishing\_\_value\_added\_\_\_\_of\_gdp is increased because Agriculture is influenced by human factors like market, labour and political aid. If there is availability of cheap labour, then labour intensive crops are grown. Places near markets grow perishable goods. Government aid in agriculture is an important factor too. Especially, during disasters, low-income group is suffered being most vulnerable. India on average suffers an economic loss of US\$7 billion each year because of natural disaster, according to the United Nations. Reduced impact of disaster frequency has

direct bearing on Agricultural, forestry and fishing. When economic damage is reduced by better preparedness, the impact is visible in long run as economic benefits of the new roads would lead to increase in agricultural production, change in the crop pattern, reduction in the transport costs, creation of new employment opportunities in other than agricultural sector, increase in the land prices, better climate for setting up cottage and agro-Industries. The variables, agriculture production and employment, have positive and significant association with GDP growth because increase in agriculture production and employment will definitely have significant and positive impact on GDP growth in the long run (Shengwen Wu et al).

When human death is reduced, the industry including construction growth is also reduced as human death at one period lag influence growth positively. When damage is reduced the industry including construction growth is also reduced as damage at two lag period influence industry including construction growth positively. However, in long run industry including construction growth will increase due to decrease in damage. When impact of no. of disasters is reduced industry including construction growth becomes slower. As no. of disaster at current period influence growth positively and one lag period negatively, therefore due to mixed effect a slight reduction is seen. However, the growth will be positively influenced by no. of disasters in long run. Here it is contended that natural disaster also bring opportunity for growth in the form of reconstruction and recovery from the impact of natural disasters. A positive, statistically significant relationship between the impact of hurricanes, tornados, and wildfires and industry gross domestic product while floods have a positive, statistically insignificant relationship with industry gross domestic product (Monica Escaleras et al).

When damage is reduced, Export of Goods and Services as % of GDP is not influenced either in short run or long run. When no. of death is reduced, Export of Goods and Services as % of GDP is not influenced either in short run or long run. When impact of no. of disasters is reduced, Export of Goods and Services as % of GDP becomes slower in short run as no. of disasters influence Export of Goods and Services as % of GDP positively. However, no. of disasters at lag one, two and three period influence Export of Goods and Services as % of GDP negatively, therefore Export of Goods and Services as % of GDP will increase with reduction of no. of disasters. Although, Findings on the effects of natural disasters on trade are more ambiguous, but at least it can be concluded that exports seem to be affected negatively by the occurrence and severity of disasters in the exporting country in long run as established by the model. The result suggests that the long-term effect of climate disasters increasing overall international trade is due to increasing imports in developing countries (Fengyu Liu et al).

When damage is reduced, Remittance increases in long run. As, damage influences remittance negatively. As 75% of remittances are used to put food on the table and cover medical expenses. Under the reduced economic damage of a country, most of the economic indicators will improve upon resulting into decrease of remittance use on regular expenses. Then the increase in remittance may play important role in economic development of any country particularly under developed and developing countries because it is an important and stable source of foreign exchange reserve and external finance.

According to the World bank, India has the largest emigrant population and is the top remittance country. In 2023, remittance was 120 Billion US\$.

During budget session in parliament on 23.07.2024, Finance Minister Smt. Niramala Sitaraman stated that "The outlook for remittance in India for 2024 is strong, with expectation that remittance growth will moderate to 3.7 %, taking... levels to USD 124" the Economic survey tabled in Parliament by Finance Minister.

It is advocated here that proclamation of remittance to the tune of 124 USD is totally subjected to reduction of economic damages by 50% in India by way of implementing disaster preparedness in holistic manner across the country, providing ample opportunities, good economic condition, perfect supply and demand, controlled inflation, adequate infrastructure etc..

The no. of death has no influence on remittance either in short run or long run. No. of disasters at current period and lag(1-3) period has also long run negative influence on Remittance when no. of disasters is reduced, Remittance has been found to be increased in long run.

Although the coefficient of no. of human deaths is not significant, still it is observed that it influences migration negatively. Reduction in damage may be understood in terms of wellbeing of a country i.e. Govt. of that country is in a position of providing ample opportunities, good economic condition, perfect supply and demand, adequate infrastructure etc. these factors diminish migration of a country.

No. of disasters at current period and lag(1) period has also short as well as long run positive influence on migration when no. of disasters is reduced, Migration value moves towards positive indicating

suppression in migration. Under the situation of increase frequency of disasters, if consequential damage is not controlled that will lead to increase in migration. Remittances increase after a disaster, thus contributing ex post to the reconstruction(Giulia Bettin et al).

As the damage influence GDP negatively, hence here we can see that a reduction in damage boosts the GDP. Therefore, the prime concern for any Government should be to reduce the economic losses emerged as a result of natural disasters. Not only direct losses need to be taken care of rather indirect losses too, as these are quite significant, even some times exceeds the direct losses.

Although, the impact of human death is not directly influencing GDP as a whole but it has significant impact in other sectors like Agricultural, as observed in this research. Therefore, cumulative effect shows that if no. of human deaths is reduced, there are chances of getting boost in over-all GDP.

As the no. of disasters has influence on GDP negatively in long run, hence here it is observed that a reduction in no. of disaster boosts the GDP. The frequency of disasters, intensity and particular area affected is not predictable under the faster changes in climate. Therefore, the prime concern for any Government should be to implement disaster preparedness plans of international level, well defined policies should be on place, identification of vulnerable areas and providing required infrastructure to combat with any eventuality. One thousand in every one million people affected by floods decrease the GDP per capita growth rate by 0.005 % ( Nourin Shabnam)

#### **Future Research Direction:**

Future research in disaster preparedness should focus on improving early warning systems, enhancing community resilience, and leveraging technology for more effective education and response. This includes understanding the impact of climate change on disaster frequency and severity, developing more inclusive preparedness programs for vulnerable populations, and integrating behavioral science insights into disaster risk reduction strategies.

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