Journal of Applied Sciences

ISSN 1812-5654

Journal of Applied Sciences 9 (2): 341-347, 2009
ISSN 1812-5654

Study of the Effects of Natural Disasters on Gross Domestic Product in Iran

[1]H. Sadeghi, [1]S. Emamgholi Sefiddasht and [2]M. Zarra Nezhad
[1]Department of Economics, Tarbiat Modares University, Jalal-Ale-Ahmad Exp. Way, Tehran, Iran
[2]Department of Economics, Shahid Chamran University, Ahvaz, Iran

Abstract: The aim of this study is to investigate the effects of occurred natural disasters in Iran on Iran's Gross Domestic Product (GDP). An Auto Regressive Distributed Lags (ARDL) model has been applied during 1978-2004 in order to investigate the effects of disasters on Iran's GDP in short term and long term. The estimation results of the model suggested the existence of long-term equilibrium between non-oil GDP and explanatory variables. The findings of the research showed that both the short-term and long-term estimated models indicate the negative effects of these disasters on the Iranian economy, particularly on per capita investment and per capita GDP. Negative impact of natural disasters on per capita GDP was, in the first stage, due to the decline in physical capital. During the renovation period, the Iranian government allocated the budget to remedy the damages incurred to the infrastructures, residential and industrial units and product capacity in order to raise the per capita GDP. The results also showed the relatively slow speed of adjustment to the disequilibria, with only 17% of any deviation being corrected each year.

Key words: Natural disasters, shock, investment, gross domestic product, ARDL, Iran

INTRODUCTION

Due to particular ecological condition and its location in quake-prone zone, Iran has experienced natural disasters, intermittently. Nine destructive earthquakes have been occurred in Iran during 1931-2004. Occurrence of intermittent droughts during 1992-2006 and overflowing of Caspian Sea during 1992-1997 have also brought significant damages to the country. These natural disasters can go even more than the above-mentioned occurrences.

Natural disasters cause three main types of impacts: Direct, indirect and macroeconomic impacts (McKenzie *et al*., 2005). Natural disasters, in the intermittent occurrence, have direct impacts on physical and human capital stock. These incur direct damages including total and partial destruction of residential areas, buildings and installations, machinery, production equipment, warehouses, farm lands and crops, dams, irrigation systems. Calculation of direct damages arising from natural disasters is difficult especially in the countries that have no proper recording system of assets as well as damages on environment (including erosion and sedimentation) and human capital. In the subsequent period of natural hazards, indirect losses include decline in the production of goods and services due to destruction of equipments, decline in agricultural outputs due to flooding of arable lands or decline in grain production, decline in industrial products due to damages incurred on factories or lack of institutions and increase in transportation expenditure due to destruction of roads or other transportation infrastructure. The third effect is the changes occurred in the macroeconomic variables that are created through the direct and indirect impacts arising from natural disasters. The natural disasters affect mostly the gross investment, balance of payments, public finance, inflation and unemployment of the country. All these affects can be reflected in the real GDP, the variable that shows the changes of general level of the economic activity of the country. However, in the case there would have been increasing demand for the renovation activities, a natural crisis can have positive impacts on GDP growth.

A natural disaster abruptly decreases the quantity of the physical capital of the economy that in turn leads to decline in production. As a result, natural disasters have negative effects on the economic growth in general and may decline the agricultural production or ruin the industrial production capacity in different cases. The

Corresponding Author: Mansour Zarra Nezhad, Department of Economics, Shahid Chamran University, Ahvaz, Iran
Tel: 0098 3331216 Fax: 0098 3335664

Table 1: Impacts of natural disasters on production level

Indicator/Effects	Anticipated post-disaster effects
GDP	Decrease and thereafter increase
Agriculture	Decline in production (in case of hurricanes, floods, droughts)
Industry	Decline arising from transportation damage, decline in capital stock and production capacities
Services	Decline arising from destruction of transportation infrastructure

Source: Albala-Bertrand, 1993

ways of financing the needed budget for the reconstruction during post-disaster period have particular effect on the GDP growth. Table 1 shows the effects of natural disasters on macroeconomic variables.

Major natural disasters have both intense short-term negative impacts and long-term negative consequences on the economic growth and development as well as poverty. The fundamental question relating to natural disasters is that whether the natural disasters are essentially negative economic shocks or they can also have positive economic effects (due to affluence in construction in post-disaster period and recovery of infrastructure and technology). Answer to this question depends on sequencing of the effects, kinds of the natural calamities (earthquake, hurricane, flood, drought, etc.), degree of vulnerability against natural hazards and other effects related to economic performance (Benson and Clay, 2004).

From economic point of view, a natural disaster is a shock that leads to decline in the human, social and physical capital stocks as well as fall in economic activities in the form of decline in production, investment and employment. Distributive consequences of these disasters are also important because the poor probably incur maximum damages from these calamities. Necessarily, segregation should be maintain between direct impacts like physical damages and decline in the level of production (like grain production) and indirect impacts like changes in the flows of economic activities, but direct and indirect impacts are often put together for calculating total cost of a natural disaster. For instance, total damage of Tsunami in 2004 was US $ 4.45 billion, which included US $ 2.9 billion direct effects and US $ 1.53 billion as indirect effects (Benson and Clay, 2004).

As a whole, relation between level of development of one country (according to its per-capita income) and influence of a natural disaster is complex and undefined. This complexity indicates the fact that the development itself is a non-linear process and there exists various routes for the development (Benson and Clay, 2004). Meanwhile, under-developed countries have the most vulnerability against natural calamities because in these countries, building codes and land use by private sector are executed in weak manner and public infrastructures are also not built according to the standards laid down to resist against disasters.

The only study has been conducted in Iran about the effects of natural disasters on the economy is the work of the United Nations in cooperation with Iran. After the earthquake of north of Iran in 1991, which has been one of the most destructive earthquakes of the world, a team from the United Nations along with Housing Foundation of Iran took step to assess the damages and evaluate reconstruction needs of the affected area. Apart from US $ 50 million of damages incurred on industrial foundations, the study evaluated the total economic damages from this earthquake about US $ 1.2 billion, 76% of which was related to housing, 5.8% related to means of living of the affected households and the rest was related to production sectors, infrastructure and other economic activities of the region (UNDP *et al*., 1996).

Regarding the literature on the macroeconomic effects of the natural disasters, we can refer to the following studies. Toya and Skidmore (2007) studied the damages of natural disasters. The findings of the research showed that countries with high per-capita incomes, education, degree of opening, financial systems, smaller administration, experience lower intensity of damages from those calamities. Noy (2006) also studied the effect of natural disasters on macro economy during short term and found that the countries with high literacy rate, higher per-capita income, jumbo government and high trade freedom have better resistance power compare to initial shock. On the other side, the countries that have dependent capital accounts, high level of foreign reserves and higher level of internal credit, are powerful against the shocks and resist against the penetration of effects to the GDP growth rate. Anbarci *et al*. (2005) linked the earthquake fatalities to the per-capita income and the level of domestic inequality (based on Land-Based Gini Coefficient) as well as evaluated and predicted other factors affecting on destructive power of earthquakes such as their magnitude, depth and proximity to the population centers. Based on a theoretical model and keeping suitable control variables constant (like magnitude, population, land area, distance from epicenter, frequency of big earthquakes and other regional factors), they predicted that number of fatalities must be a decreasing function of the levels of per-capita income of a country and equality and confirmed the predictions using negative binominal estimation method with coincidental and constant estimators. Kirigia *et al*. (2004) in accounting economic effects and human damages arising from natural disasters in 46 African nations, who are the members of World Health Organization (WTO), showed that death of a single person under such disaster has decreased the GDP to the rate of 0.01828 dollars. Benson (2003) in his study about the effects of natural disasters on long-term growth found that countries, which repeatedly experienced the natural disasters during 1960-1993, accumulated lower rate of growth compare to the countries experiencing less natural disasters. Narayan (2003) about the damages resulting from hurricane to substructures, industrial and agricultural activities in Fiji indicated that import and export declined (exports with high percent) with the effect of 2003 hurricane and caused deficit balance of payment. Likewise, actual GDP, private consumption, income, investment, saving, national welfare declined. Skidmore and Toya (2002) studied the long-term effects of natural disasters on economic growth. They acquired abundance of natural disasters for each country during 1960-1990 and have normalized them with respect to the extent of each country. They have determined the correlation of this standard with economic growth, human and physical capital stocks and exploitation of total factors. Used damages of natural disasters for estimating the effects on the rate of family savings and as such found that with assuming other factors determining saving, enhancement of damages arising from geological and environmental atrocities distinctively with the rate of savings of the families have correlation. Selcuk and Yeldan (2001) in their assessment of the 1999 earthquake in Turkey on distinct macroeconomic variables in short and long term applying General Equilibrium (GE) model showed that the effects of the primary earthquake on GDP, taking into account the policies followed by the government and international assistance, have fluctuation from 4.5% negative to 0.8% positive GDP. Benson and Clay (2004) and Cochrane (1994) studied the effects of natural disasters on the country's debt. Using a growth model of Kenzy and identifying negative shocks in the form of lessening public and private capitals and augmenting government expenditure for emergency helps, he reached to the conclusion that natural disasters can reduce the confidence level of a country, enlarge the debt rate of foreign loans and increase the debt stockpile with declining investment and long-term growth. Albala-Bertrand (1993) in his experiment about the relations between natural crisis and its potential effects on the rate of growth output, reached to the conclusion that the emergence of natural disasters cause minimum GDP growth in short-term, no change in inflation, increase of investment and trade deficit as well as growth in budgeting.

MATERIALS AND METHODS

To explain the effects of natural disasters on GDP in Iran during 1978-2004, we first assume that desirable capital stock is related to level of production in the following way:

$$K_t^* = \beta_0 + \beta_1 Y_t + U_t \tag{1}$$

where, desirable capital stock K_t is desirable capital stock in the time (t), Y_t is production in time (t) and U_t is residual term. From the view of natural disasters, shocks incurred on economy can be written as:

$$U_t = DMG_t + \varepsilon_t \tag{2}$$

where, DMS_t is the damage arising from natural disaster in time (t) and thus we can write:

$$K_t^* = \beta_0 + \beta_1 Y_t + DMG_t + \varepsilon_t \tag{3}$$

Thus, based on the adjustment hypothesis of existing capital, changes of capital stock take place according to the following model:

$$K_t - K_{t-1} = \delta(K_t^* - K_{t-1}) \quad 0 \le \delta \le 1 \tag{4}$$

where, δ is adjustment coefficient and K_t-K_{t-1} is equal to gross investment which is shown with INV:

$$INV_t = (\delta\beta_0 + \delta K_{t-1}) + \delta\beta_1 Y_t + \delta DMG_t + \delta\varepsilon_t \tag{5}$$

by solving the above equation in terms of Y_t, the final equation will be as:

$$Y_t = \alpha_0 + \alpha_1 INV_t + \alpha_2 DMG_t + \eta_t \tag{6}$$

in which the effect of the other variables is summarized in the intercept (α_0) and η_t shows the residual term with identically independent distribution (i.i.d).

Equation 6 based on the size of damage of natural disasters is on the situation that the developing countries like Iran at the time of occurrence of disaster are confronted with basic deficiencies and shortages (especially in the affected zone). As a result, level of economic activities declines at least for short-term but in the later stage (during renovation) with the allocation of enough financial resources, economic prosperity is created and GDP is increased. Results of this process show that gap between expected level of growth and actual level of growth become wider after natural calamity.

Therefore, effect of natural calamities on national economy initially is diminished and thereafter it is increasing, which can be observed in Fig. 1, in which natural disasters have occurred in the periods t_1 and t_2:

Inclusion of gross fixed capital formation (gross investment) is due to positive compensatory effect of this variable after the emergence of the natural disaster on GDP.

Rewriting Eq. 6 in per capita form gives rise to the final model:

$$PGDP = \alpha_0 + \alpha_1 PINV + \alpha_2 PDMG \tag{7}$$

where, PGDP, PINV and PDMG indicate per capita GDP, per capita investment and per capita natural damages, respectively.

According to Fig. 1 positive and encouraging effect of investment growth on GDP, it is expected the following restrictions on the coefficients of model (7) :

$$\alpha_0 \succ 0, \quad \alpha_1 \succ 0, \quad \alpha_2 \prec 0$$

The statistics of GDP and gross fixed capital formation variables during the study period (1978-2004) have been extracted from WDI, 2006 and as such data about natural disasters damages have been extracted from EM-DAT (www.em-dat.net) database affiliated to the University of Louvain, Belgium. Per capita GDP, PGDP, (in constant prices of 2000) is defined as Gross Domestic Product divided by labor force. Per capita damages of natural disasters, PDMG, (in constant price level of 2000) is calculated as damages divided by labor force. Per capita gross fixed capital formation or per capita investment, PINV, (in constant price of 2000) is measured as gross investment divided by labor force.

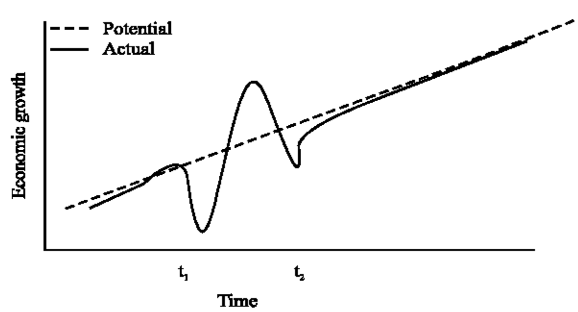

Fig. 1: Impacts of natural disasters on economic growth

Table 2: Results of unit root test of actual research variables

	Dickey-Fuller test statistics	
	Level	First difference
Variable	With trend and intercept	With trend and intercept
PGDP	-2.61	-4.62
PINV	-3.96	-
PDMG	-2.41	-5.48

McKinnon critical value of tests at the level 5%: -3.69

In order to prevent the spurious regression, it is necessary to conduct the required unit root tests. Table 2 explains the results of unit root test:

According to Table 2, PGDP and PDMG are integrated of degree one, i.e., I (1), but PINV is integrated of degree zero, i.e., I (0). Therefore analysis through ARDL method, in which the short-term dynamism is considered in the model, leads to more exact coefficients compare to other methods. The dynamic model is as follows:

$$Y_t = aX_t + bX_{t-1} + cY_{t-1} + u_t \tag{8}$$

To decrease the estimation bias of regression coefficients in small samples, it is advised to use sufficient lags. Then the above Auto-Regressive Distributed Lags (ARDL) model is used:

$$\phi(L,P)Y_t = \sum_{i=1}^{k} b_i(L,q_i)X_{it} + c'w_t + u_t \tag{9}$$

in which:

$$\phi(L,P) = 1 - \phi_1 L - \phi_2 L^2 - ..... - \phi_P L^P \tag{10}$$

$$b_i(L,q_i) = b_i + b_{i1}L + ... + b_{iq}L^q, \quad i = 1, 2,...., k$$

where, L is lag operator, w is a vector of constants including intercept, dummy variables, time trend or exogenous variables having constant lags and p and q are maximum number of lags for Y and X variables. Equation 3 is estimated for all possible orders of p and q in $(m+1)^{(k+1)}$ stages using Microfit software in which m is the maximum lag determined by researcher and k is the number of explanatory variables.

At the later phase, one equation is selected by using Akaike Information Criterion (AIC), Schwarz-Baysian Criterion (SBC), Hannan-Quinn Criterion (HQC) or adjusted coefficient ($\bar{R}^2$). Usually in the samples less than 100, Schwarz-Baysian Criterion is used to conserve maximum degree of freedom.

For calculating long-term coefficient model, the same dynamic model is used. Long-term coefficients related to x variables are given by the following equation:

$$\theta_i = \frac{\hat{b}_i(1,q_i)}{1-\hat{\phi}(1,p)} = \frac{\hat{b}_{i0} + \hat{b}_{i1} + ... + \hat{b}_{iq}}{1-\hat{\phi}_1 - ... - \hat{\phi}_p} \quad i = 1, 2,...., k \tag{11}$$

Then, to overcome the spurious regression of the long-term relationship, the following hypothesis is tested:

$$H_0 : \sum_{i=1}^{P} \phi_i - 1 \geq 0, \ H_a : \sum_{i=1}^{P} \phi_i - 1 < 0 \qquad (12)$$

The null hypothesis (H_0) indicates the lack of co-integration or long-term relationship among model variables. Since the condition that short-term dynamic relation approaches to long-term equilibrium is that sum of coefficients of lagged dependent variables (ϕ_i) will be less than one. To test the co-integration relation, the sum of ϕ_is minus 1 is divided by sum of standard deviation of them ($\sum \phi_i$) :

$$t = \frac{\sum_{i=1}^{P} \hat{\phi}_i - 1}{\sum_{i=1}^{P} S_{\hat{\phi}_i}} \qquad (13)$$

If absolute value of t in (13) is greater than the absolute value of critical value presented by Banerjee *et al*. (1998), then the null hypothesis will be rejected and existence of long-term relations will be accepted. In the substituting process, the method proposed by Pesaran and Yongcheol (1996) and statistics F calculated by them would be applied to study the long term relations between variables. Relying on the co-integration among a set of economic variables, Error Correction Model (ECM) can be used. In this model, fluctuations of short-term variables are related to long-term equilibria. This model is a special from of Partial Adjustment Models (PAMs), in which with the entrance of stationary residual terms resulting from long-term relationship, speed of closeness of short term quantities of variables to long-term equilibrium is measured.

Error Correction Model (ECM) is estimated in two stages: first, long term relation is estimated to be sure that it is not spurious. Second, when residual lag of long-term relation is used as error correction coefficient, the following equation is regressed:

$$\Delta Y_t = a + b\Delta X_t + cU_{t-1} + e_t \qquad (14)$$

Error correction coefficient (c) with negative sign (which is also expected) would indicate error correction speed and desire to long term equilibrium. This coefficient shows that in each period, how many percentage of disequilibrium of dependent variable were adjusted and become closer towards long-term relation.

RESULTS AND DISCUSSION

As indicated, with reference to the differences in degrees of integration, it is necessary to use auto-regressive distributed lags (ARDL) model for estimating the experimental model (7) because in most of the economic studies, macroeconomic variables represent their impacts with time lags. Results of dynamic equation estimation (where dependent variable with one lag appears in the line of explanatory variables) are shown in Table 3 in which ARDL (1, 0, 0) is applied and optimum lag is 1 based on SBC criterion.

According to Table 3, in the short term PGDP with one lag affects the level of same variable with coefficient +0.31. Likewise, per capita gross investment has positive impact on per capita GDP and PGDP that is compatible with economic theory. On the other side, per capita damages of natural disasters, PDMG, in constant prices, negatively affect the level of economic activities and thus, the relationship between PGDP and PDMG is negative. Except for PDMG variable that is significant at 10% level, rest of the variables are significant at the level of 5% and statistic F indicates whole significance of the regression. Before the estimation of long-term coefficients and Error Correction Model (ECM), diagnostic tests are necessary for the accuracy of the model (including tests on lack of serial correlation, functional form specification, normality of error terms and heteroscedasticity). In Table 4 and according to F and LM statistics at 5% significant level, the estimated model do not encounter the problem of auto-correlation of error terms and heteroscedasticity, the specified form is correct and error terms (residuals) are normally distributed.

Table 3: Autoregressive Distributed Lag Estimates: ARDL (1, 0, 0); Dependent variable: Per capita Gross Domestic Production = PGDP)

Regressor	Coefficient	T-Ratio (Prob)
PGDP (-1)	0.31487	3.9120 (0.001)
PINV	0.63550	3.8445 (0.001)
PDMG	-52121.2	-1.7513 (0.093)
C	2403.0	9.6217 (0.000)
R^2 = 0.885	$\bar{R}^2$ = 0.869	F (3, 23) = 58.9840 (0.000)
AIC = -182.9780	SBC = -185.5697	SD of dependent variable = 550.0664

Note: R^2 refers to identification coefficient, $\bar{R}^2$ to adjusted identification coefficient, F to Fisher statistics, AIC to Akaike information criterion, SBC to Schwarz Bayesian criterion and SD to standard error

Table 4: Results of diagnostic tests for PGDP

	Statistic	
Test	LM	F
Serial correlation	2.5856 (0.108)	2.3299 (0.141)
Functional form	0.69063 (0.406)	0.57751 (0.455)
Normality	3.3225 (0.190)	Not applicable
Heteroscedasticity	0.11038 (0.740)	0.10262 (0.751)

Note: LM refers to lagrange multiplier statistic and F to Fisher statistic

Considering the differences in the integration degrees of the model variables, the condition of tendency of the dynamic model towards long-term equilibrium and the existence of co-integration relationship among variables is that sum of coefficients of lagged dependent variable should be less than one. Here, the t-test based on relation (13) is:

$$t = \frac{0.31487 - 1}{0.080486} = -8.51$$

Since absolute value of t is greater than the critical absolute value in Banergee, Dolado and Mestre's Table (with 50 observations, 2 explanatory variables and inclusion of intercept, except for lagged dependent variable) is -4.43. So, the existence of long-term equilibrium relations among variables is confirmed. Table 5 shows the estimation results of long-term equilibrium model.

Although the per capita damage of natural disasters (PDMG) affects, at 10% significant level, the per capita GDP, PGDP, but as a whole, presence of long-term relation between these variables is confirmed. In other words, if all conditions are constant, a long-run equation is calculated as:

$$PGDP = 3507.3+0.928*PINV-76074.4*PDMG \quad (15)$$

For estimating the error correction model, error terms of co-integration regression in long-term equation form with one lag is considered as an explanatory variable along with first difference of other variables. Table 6 shows the estimated results of such model.

According to the Table 6, the coefficient of lagged error correction term is equal to -0.685 which is significant statistically at the 5% confidence level. This coefficient indicates that in each period only 17% of disequilibrium is adjusted; therefore adjustment speed is relatively slow.

Table 5: Estimated long run coefficients of per capita gdp:ardl(1, 0, 0)

Explanatory variable	Coefficient	t-ratio (Prob)
PINV	0.92756	5.6583 (0.000)
PDMG	-76074.40000	-1.6936 (0.104)
C	3507.30000	14.9684 (0.000)

Table 6: Error correction model for per capita GDP: ARDL (1,0,0)

Explanatory variable	Coefficient	T-ratio (Prob)
dPINV	0.6355	3.8445 (0.001)
dPDMG	-52121.2	-1.7513 (0.093)
dC	2403.0	9.6217 (0.000)
ecm (-1)	-0.68513	-8.5124 (0.000)
$R^2 = 0.82$	$\bar{R}^2 = 0.79$	F (3,23) = 35.3485 (0.000)
AIC = -182.98	SBC = -185.57	SD of Dependent Variable = 441.9

Note: R^2 refers to identification coefficient, $\bar{R}^2$ to adjusted identification coefficient, F to Fisher statistics, AIC to Akaike information criterion, SBC to Schwarz Bayesian criterion and SD to standard error

CONCLUSION

With the help of a method proposed by Pesaran and Yongcheol. (1996) for analyzing co-integration as well as auto-regression distributed lag model (ARDL) and theoretical and experimental studies about the effects of natural disasters on different economic variables, the present article studied the damages incurred by natural disaster on the non-oil GDP as a negative shock on the whole level of economic activities during 1978-2004. Explanatory variables in this study included damages from natural calamities and fixed gross capital formation as strong and powerful incentive in the movement of the level of total economic activities.

Estimation results of ARDL (1, 0, 0) confirm the existence of long-term equilibrium between non-oil GDP and explanatory variables. On the other side, results of short-term dynamic estimation and long-term model indicated the positive effects from the investment and negative effects of damages incurred by natural disasters on the non-oil gross domestic product are accepted. In other words, with the emergence of natural disasters, initially GDP growth declines and then in the stages of renovation and reconstruction, it begins to increase. Negative impact of natural disasters on per capita GDP in the first stage is due to decline in physical capital but during renovation, the government enters into the operation and allocates the budget to remedy the damages incurred upon the capital (infrastructures, residential and industrial units deserted or the products lost). Likewise, estimated results of error correction model indicate the relatively slow speed of adjustment in the disequilibria in a way that in each period only 17% of disequilibria is adjusted.

REFERENCES

Albala-Bertrand, J.M., 1993. Natural disaster situations and growth: A macroeconomic model for sudden disaster impacts. World Dev., 21: 1417-1434.

Anbarci, N., M. Escaleras and Ch.A. Register, 2005. Earthquake fatalities: The interaction of nature and political economy. J. Public Econ., 89: 1907-1933.

Banerjee, A., J.J. Dolado and R. Mestre, 1998. Error-correction mechanism tests for cointegration in a single-equation framework. J. Time Ser. Anal., 19: 267-283.

Benson, C., 2003. Macroeconomic Concepts of Vulnerability: Dynamics, Complexity and Public Policy. In: Mapping Vulnerability: Disasters, Development and People, Bankoff, G., G. Frerks and T. Hilhorst (Eds.). Earthscan Publishers, London, ISBN-10:1853839647.

Benson, C. and E.J. Clay, 2004. Understanding the Economic and Financial Impacts of Natural Disasters, Disaster Risk Management Series, No. 4. The World Bank, Washington, DC., ISBN-8213-5685-2.

Cochrane, H.C., 1994. Disasters, indebtedness and faltering economic growth. Proceedings of the 9th International Seminar on Earthquake Prognostics, September 9-23, San José, Costa Rica, Hazards Assessment Laboratory, Colorado State University, Boulder.

Kirigia, J.M., L.G. Sambo, W. Aldis and G.M. Mwabu, 2004. Impact of disaster-related mortality on gross domestic product in the WHO African Region. BMC Emerg. Med., 4: 1-1.

McKenzie, E., B. Prasad and A. Kaloumaira, 2005. Economic impact of natural disasters on development in the Pacific. Economic Assessment Tools, South Pacific Applied Geoscience Commission (SOPAC) and the University of the South Pacific (USP), Fiji Islands. http://www.ausaid.gov.au/publications/pdf/impact_pacific_tools.pdf.

Narayan, P.K., 2003. Macroeconomic impact of natural disasters on a small island economy: Evidence from a CGE model. Applied Econ. Lett., 10: 721-723.

Noy, I., 2006. The macroeconomic costs of natural disasters: preliminary text. Working Paper of Department of Economics, University of Hawaii, Honolulu.

Pesaran, M.H. and S. Yongcheol, 1996. Co-integration and speed of convergence to equilibrium. J. Econ., 71: 117-143.

Selcuk, F. and E. Yeldan, 2001. On the macroeconomic impact of the August 1999 earthquake in Turkey: A first assessment. Applied Econ. Lett., 8: 483-488.

Skidmore, M. and H. Toya, 2002. Do natural disasters promote long-run growth. Econ. Inquiry, 40: 664-687.

Toya, H. and M. Skidmore, 2007. Economic development and the impacts of natural disasters. Econ. Lett., 94: 20-25.

UNDP (United Nations Development Program), UN-HABITAT (United Nations Human Settlements Program) and Housing Foundation of Islamic Revolution, 1996. Economic damages of Roudbar earthquake in Northern Iran in 1990. Housing Foundation of Islamic Revolution of Iran, Iran.