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The Significance of Greenhouse Gas Emission and Use of Chemical Fertilizers on Fish Production of Bangladesh

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Abstract: The recent performance of Bangladesh is glowing in case of inland fish production. But sustainability of such healthy-looking condition is very much thought-provoking as environmental damage is also noteworthy in Bangladesh. This article examined mainly the relationship between the environmental damage and its impact on fish production in Bangladesh. This paper uses time series data from 1971-2018 on total fish production (FP), emission of Greenhouse gas (GHG) and use of chemical fertilizers (CF) in Bangladesh. Here researchers use emission of GHGs (proxy to air pollution) and total use of chemical fertilizers (proxy to water pollution) as proxy variables to represent environmental damage. Cointegration test shows that there is long run negative relationship between fish production and GHGs emission but positive relationship between fish production and use of chemical fertilizers. Granger Causality test shows that both fish production and use of chemical fertilizer have causality to GHGs emission. Government steps along with public awareness is required to mitigate environmental damage and maintain stable fish production in the long-run.

Keywords: Environmental damage, fish production, Greenhouse gas, chemical fertilizer, and cointegration.

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1. Introduction

Environment and human life are diligently linked to each other. The blessing of the environment to the living being is immense. However, such benediction becomes curse when it damages. Environmental damage specifies the erosions or worse conditions of the environment, which occurs when natural resources are depleted such as air, water, and soil; also includes the destruction of ecosystem and the extinction of wildlife.

Land degradation and pollution of water, air or soil are brought about by the misuse of resources, poor planning, poor infrastructure and poor governance and monitoring. Deforestation is another element of environment damage all over the world. Deforestation occurs as people are cutting down trees to get free land, for wood, to make more home or industries etc. Acid rain is a one of the human made sources of environmental damage. It occurs when emission of sulfur dioxide and nitrogen oxide combines with moisture, which present in the air. It is a result of chemical reaction. It can acidify rivers, streams, soil, plants etc. Pollution is the key components of environmental damage. Air pollution occurs due to smoke emitted by the vehicles and factories like CFC, nitrogen oxide, carbon monoxide etc. Water pollution occurs due to many industrial wastes when dumped into the rivers, agricultural runoff (pesticides and fertilizer which contain Phosphorus). Soil pollution creates when we incorporate many unwanted chemicals in the soil such as insecticides, pesticides. Release of industrial waste, mining, acid rain, deforestation also pollute soil. Another type of pollution that degrade environment is sound pollution. The most common reasons of sound pollution are vehicles, loud speakers, and machine sound in mills etc.

The current situation of environment in Bangladesh is not at all equilibrium. Stern air, water and noise pollution are threatening human health, ecosystems and economic growth of Bangladesh. In Bangladesh environmental damage is also triggered due to poverty, over-population and lack of awareness on the subject. It is created by deforestation, destruction of wetlands, soil erosion and natural calamities (Alam, 2009). According to the statistics of the global Environmental Performance Index for 2014 Bangladesh is the ninth-most polluted country in the world. Bangladesh has also been listed as the country with the most polluted air quality around the globe. The overall ranking indicating environmental disaster was measured for eight categories: health impacts, air quality, water and sanitation, water resources, agriculture, forests, fisheries and biodiversity and habitat. It has been said that the poorest performers in 2014 are countries with "significant political or economic strife," suggesting these factors can sideline environmental policy (Unanimous).

Bangladesh is in the third position in terms of inland fish production. Bangladesh earned Tk. 4,500 crore by exporting around 69,000 metric tons of fish and fish products and the average per capita fish consumption in the country is 62.58 grams per day, against the daily requirement of 60 grams. Fisheries sector contributed 3.57 percent to the national GDP in FY18 (FAO, 2018). But such achievement could be unsustainable due to environmental damage in Bangladesh. Two significant sources of environmental damage are emission of GHGs (proxy to air pollution) and use of chemical fertilizers (proxy to water pollution). So, this study attempts to meet the following objectives:

1. To find out the long run relationship of GHGs emission and use of Chemical fertilizers on fish production of Bangladesh.

2. To examine causality among them.

2. Literatures review

There are several research works on closely related issues. Among which the followings are noteworthy:

Alam et al. (1998) showed the effect of heavy metal on the aquatic environments in Bangladesh. According to them the deleterious effects on the aquaculture environment eventually cause the decline of fish production. Degradation of the environment through natural and anthropogenic interventions has been identified as the primary cause for the decline in open water capture fishery production. Due to rapid industrial development of the country, industrial pollution may, in time, become a threat to the aquatic environment.

Cao et al. (2007) identified that the quality and quantity of waste from aquaculture depends mainly on culture system characteristics and the choice of species, but also on feed quality and management. The researchers also stated that wastewater without treatment, if continuously discharged into the aquatic environment, could result in remarkable elevation of the total organic matter contents and cause considerable economy lost. They recommended that proper waste treatments should apply to reduce such damage.

Ghose (2014) reviewed the performance of fisheries sector in Bangladesh and the challenges it is facing. According to his paper, the fisheries sector is confronted with challenges posed by numerous natural and anthropogenic causes such as climate change, natural disasters, unbalanced urbanization and industrialization, overfishing and environmental pollution. The combined effect of these factors is posing significant threat to the income and food security of the population and urges for immediate actions by government and policymakers.

Islam and Yasmin (2017) stated that over exploiting nature of aquaculture practices creates environmental suffering. They showed that the stress of aquaculture over environment starts with the collection of fish seed. Due to lack of waste the water treatment facility in hatcheries or culture farms and that is why recycle of waste water or treat water before discharge to the nature is not possible till now. In most cases, the used water or wastage of aquaculture is being released to the natural waterbody or main river stream without any treatment, which leads to the disease outbreak, invasion of undesired species or foreign species, imbalance in biodiversity and ecosystem.

Some studies analyze the effects of water pollution and its impacts on aquaculture. Other examines the effects of aquaculture practice on water quality. This paper uses the secondary data to scrutinize the effects of Greenhouse gas emission and use of chemical fertilizers on total fish production of Bangladesh.

3. Method

This section analyzes the process of describing the empirical results. Three types of tests such as unit root test, cointegration test and Granger causality test are used to inspect the model.

3.1. Unit Root Test

In first part unit root test need to run in order to know whether all the variables are (integrated) stationary at the same level. Here fish production (FP) is termed as a dependent variable and use of chemical fertilizers

(CF) and emission of Greenhouse gases (GHGs) are independent variables. The unit root test is done by the augmented Dickey-Fuller test. The following equation represents the augmented D-F test with a constant and a trend as:

$\Delta Yt = \alpha 1 + \alpha 2 + \beta\ Yt\text{-}1 + \Omega i \sum \Delta Yt\text{-}1 + ei$.....................(1)

Where, $\Delta Y_t = Y_t - Y_{t-1}$ and Y is the variable which is in consideration and m represents lag of dependent variable with the Akaike Information Criterion and e_i represents stochastic error term. In case of unit root the null hypothesis requires that $\Omega=0$. If, it is found that the null hypothesis is rejected in the level of data which implies the used series is stationary and no differentiation will be needed in that series in order induce stationary. Otherwise the data should be differentiated in first and sometimes in second degree to check the data are stationary or not.

3.2. Cointegration Test

To undertake cointegration test the Engle-Granger two-steps method (Engle-Granger, 1987) is useful one. In first step the integration between the variables need to identify and in the second step the Ordinary Least Square (OLS) is employed to estimate the residuals. Engle-Granger method verifies the long-run equilibrium among the variables. The cointegration among these series was made through the Johansen-Juseliuscointegration technique. Two types of test statistics are used to justify the cointegrated vectors, as Trace test and Maximum Eigen value test statistic.

These are given below:

$$\lambda trace = T \sum_{i=r-1}^{n} \ln(1 - \lambda i) \text{.............................(2)}$$

$$\lambda max = -T \ln(1 - \lambda r + 1) \text{..(3)}$$

In the max statistic alternative roots which are r, r+1should be tested.

Where r+1 will be tested to verify it is rejected or not in favor of r root. Johansen (1988) argued these two test have non-standard distribution under the null hypothesis, which provide approximate critical values for the statistic represented by Monte Carlo methods. The alternative hypothesis of trace test requires that the cointegrating vector is either equal or less than r+1, whereas r+1 is hold for the maximum Eigen value test. Substituting FP with LnFP, GHG with Ln GHG and CF with Ln CF it carries out the Johansen's maximum likelihood procedure.

3.3. Granger Causality Test

Finally the Granger Causality test is carried out for checking the causal relationship between two variables such as X and Y. If a single value of X causes Y then it is assumed that the previous values of X must have some information that assists predict Y before and after the information contained in the previous values of Y alone assuming both variables are stationary. This test is solely based on the time series data and for making prediction the following regressions is used:

$$Y_t = \delta + \sum_{i=1}^{m} \alpha i Y_{t-1} + \sum_{i=1}^{n} \gamma i \quad X_{t-1} + v_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$X_t = \kappa + \sum_{i=1}^{m} \mu i \, X_{t-1} + \sum_{i=1}^{n} \phi i \quad Y_{t-1} + \eta_i \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

v_i and η_i are the white noise disturbance terms which are assumed stationary where m and n are lags. Both equations represent the present values of any one of the variables are related to the past values of itself and another variable. X will Granger cause Y if the calculated F-statistics is significant at conventional level and similar will occur in case of Y to X. The lag length should be taken on the basis of Akaike information criterion.

4. Findings and Discussions

In this study the annual data on fish production (FP), use of chemical fertilizers (CF), and emission of GHGs (GHGs) have been taken for the period of 1971 to 2018. The main sources of data are the Data Bank of the *World Development Indicators* published by World Bank and Bangladesh Bureau of Statistics (BBS). At first all variables were converted into natural logarithm. The results are obtained by using econometric software Eviews version 9.5.

4.1. Unit Root Test

Variables are tested for the unit root to find out whether they are stationary or non-stationary according to the ADF test. Here test is applied in series and at first difference with lag parameters determined by Schwarz Information Criterion. The results are reported in Table 1.

Table 1: Unit-root test of fish production, chemical fertilizers, and emission of GHGs

Unit Root Test				
	Without Trend and Intercept		**With Trend and Intercept**	
	Level	**First Diff**	**Level**	**First Diffe**
Ln FP	**2.770624**	**-2.165749****	**-3.957808****	**-5.956453*****
LnGHGs	**1.693382**	**-6.420804*****	**-0.721605**	**-7.088573*****
LnCF	**3.387268**	**-2.870872****	**-1.848131**	**-7.711911*****

Note: ***, ** and * represent significant at 1%, 5% and 10% level respectively. In terms of Akaike information criteria, it is assumed that the optimal leg length is 1.

The result of ADF unit root test shows that with the presence of unit roots in the original series such as in Ln FP and, Ln CF, Ln GHG which are non-stationary in the levels but the first differences remove the unit root (that is, they are integrated at order one). All the variables are I(1). As the variables become stationary the conintegration test could be run with these data.

4.2. Cointegration Test

The cointegration test is used to find out the long-run integration among the variables. The following table represents the result of cointegration test:

Table 2: Cointegration test of FP, CF and GHG

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.560538	46.62784***	29.79707	0.0003
At most 1	0.173815	8.806455	15.49471	0.3836
At most 2	0.000507	0.023350	3.841466	0.8785

Note: ***, ** and * represent significant at 1%, 5% and 10% level respectively.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.560538	37.82138***	21.13162	0.0001
At most 1	0.173815	8.783106	14.26460	0.3047
At most 2	0.000507	0.023350	3.841466	0.8785

Note: ***, ** and * represent significant at 1%, 5% and 10% level respectively.

Normalized cointegrating coefficients (standard error in parentheses)		
LNFP	LNGHGS	LNCF
1.000000	0.236691	-1.302699
	(0.52621)	(0.12921)

The Johansen and Juselius (1990) test has been done here with taking 1 lag length. In case of both Trace and Max tests the none hypotheses are statistically significant where calculated statistics are higher than 5% critical values and probability is lower than 1%. But in the both tests the at most 1 and 2 hypotheses are not statistically significant. As null hypotheses in case of none are rejected so it can be said that the variables are cointegrated in the long run. That means there exists long-run relationship among these variables.

The values of the normalized cointegrating coefficient represents the opposite results as the sign shows in the table (last box of the above table). So here it is clearly visible that in the long run Greenhouse gas emission (Ln GHG) has negative relationship with fish production (as table shows 1% increase in emission of GHGs leads to 0.23% decrease in fish production). Conversely, the use of chemical fertilizers (CF) has positive effect on fish production (as table shows 1% increase in use of chemical fertilizers leads to 1.3% increase in fish production) which is very interesting but the excessive and unconscious use of chemical fertilizers can damage both soil nutrients and water quality as a result a negative effect on fish production.

4.3. Granger Causality Test

Here the following table represents the results of Granger causality test among the three variables:

Table 3: Granger causality test of FP, CF and GHG

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGHGS does not Granger Cause LNFP	46	1.59372	0.2155
LNFP does not Granger Cause LNGHGS		3.11173*	0.0552
LNCF does not Granger Cause LNFP	46	26.3244*	4.E-08
LNFP does not Granger Cause LNCF		0.33707	0.7158
LNCF does not Granger Cause LNGHGS	46	1.08969	0.3459
LNGHGS does not Granger Cause LNCF		0.25899	0.7731

Note: ** and * indicate significant at 1% and 5% level respectively.

Here, Granger Causality test detects that LNFP granger cause to LNGHGs and LNCF Granger Cause to LNFP as in these two cases null hypotheses are rejected at 5% level. That is fish production has causal effect on GHGs emission and use of chemical fertilizer has causal effect on fish production. No bidirectional causality has been detected.

5. Conclusion

Excessive emission of GHG will ultimately increase the water temperature that will hamper the aquatic environment and will reduce fish production. The increasing use of chemical fertilizer in the land is very harmful for water. Unconscious use of chemical on the land seriously pollutes the water which hampers the fish production. So, the farmers should be very watchful to use chemical fertilizers in their lands. Government could take some protective laws to reduce Greenhouse gas emission and unsafe use of chemicals in the peasant farming.

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