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   REVIEW OF LITERATURE

   NEED/IMPORTANCE OF THE STUDY

   STATEMENT OF THE PROBLEM

   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

   RECOMMENDATIONS/SUGGESTIONS

   CONCLUSIONS

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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

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- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

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AN ARDL BOUNDS TESTING APPROACH TO DETERMINANTS OF WETLAND FISH PRODUCTION: A CASE OF TEMPERATE VALLEY OF KASHMIR, INDIA

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ABSTRACT

This paper strives to empirically investigate the impact & possibility of existence of long-run relationship between fish production and economic & environmental factors in temperate valley of Kashmir using time series data for the period 1965-2010. The inclusion of rainfall, wetland water level and atmospheric temperature variables in the study was to purposely examine the effect on wetland fish production. Three models (model 1 for total fish production, model 2 for native Shizothorax specie and model 3 for exotic carp specie) were estimated using ARDL approach to test cointegration and to delineate the short run and long run equilibrium relationship between fish production and the determinants. Evidence of long run relationship between fish production and some determinants was found. By and large, our analysis reveals that the environmental factors have an impact (negative/positive) on fish production and suggests the need of considering environmental determinants into fisheries policy making.

KEYWORDS

ARDL, Carp, Long-Run & Short-Run Equilibrium, Shizothorax, Wetland Fish Production.

1. INTRODUCTION

Wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing; fresh, brackish, or salty, including areas of marine water the depth of which at low tide does not exceed six meters"

www.ramsar.org

Along with farming, fishing is one of the oldest occupations of humankind. Fishing has existed as a means of obtaining food since the Paleolithic period about 40,000 years ago (B. Gunda, 1984). The importance of the fisheries sector has been highlighted as a major source of food, income, livelihood for a large section of economically backward population in developing economies. As an important activity of self-employment, the increase in employment in the fisheries sector outpaced world population growth and employment in traditional agriculture (Begum S., 2006). Fisheries provide employment for over 38 million fishers in developing countries, mainly in Asia (84%). Total world employment in fisheries including associated trades, input suppliers and fish processing probably exceeds 150 million (FAO, 2003). World production of fish products (excluding seaweed and marine mammals) was estimated to have reached 141.6 million tonnes in 2008, a slight increase over 2007, driven by a 2.5 percent expansion in aquaculture to 51.6 million tonnes, while capture fisheries remained stable around 90 million tonnes. However, the world inland fisheries have steadily declined since the 1997 as most inland capture fisheries (all fresh water fish except aquaculture) are exploited at or above their maximum sustainable yields (FAO, 2010a). Globally, inland fisheries production (including aquaculture) increased 2% per year from 1984 to 1997; although in Asia (Asia produces 64% of the world's inland fish catch) the rate has been much higher (7% per year since 1992) (FAO, 2008). The fish production from developing countries account for over 60% of total world fish production – the major producers are China, Peru, India, Indonesia, and Chile. India now is third largest producer of fish in the world. Among the Asian countries, India ranks second in culture and first in capture fisheries. Indian share in global production has reached 4.36% with 9.92% share in inland and 2.8% in marine (Ministry of Food Processing Industries, Annual Report, 2006-07). In India, the trend of inland fish production is continuously on rise since 1950. The inland fish production of India has increased from 218 thousand tonnes in 1950-51 to 4636 thousand tonnes in 2008-2009 (Economic Survey, 2008-09). More than seven million fishers and their family members in India depend on fisheries for their livelihood (Indian Livestock Census, 2003). The number of people engaged in fishing related activities other than actual fishing, marketing of fish (391000), repair of fishing nets (245100), processing of fish (46200), & other activities (334700) (Hand Book on Fisheries Statistics, 2004).

Jammu and Kashmir State (in particular temperate Kashmir valley) is dotted with vast and varied fishery resources in the form of lakes, ponds, and rivers which are very productive and offer extensive opportunities for augmenting inland fish production. The state has total 1411 wetlands occupying 389261 ha area. Out of total 1411 wetlands 1143 such wetlands have been mapped having an area of 109170 ha (27.88%). In addition, 2240 small wetlands (< 2.25 ha) have been demarcated that can facilitates the farming of more than 40 million tonnes of fish annually. These wetlands are mainly high altitude wetlands and only some glacial lakes (altitude 3200-3819 m) of Kashmir contain fish, such as brown trout and the endemic schizothoracine Diptychs maculatus (www.wetlandsofindia.org). The Kashmir valley is a land of wetlands (lakes and rivers). The river Jhelum, Wular, Dal, Manasbal, Nagin, Anchar, Kaunsar Nag, Gangabal, Hokersar, Gilsar, Khushalsar, Haigam Wetland, Gadsar, Zumsar, Gangabal, Nundkol, Kishansar, Sheeshnag, Kausarnag, Nilnag, Vishan sar, Kishan sar, Khanpur and Waskur are the water bodies were fish is in abundance. The river Jhelum, Wular Lake and Dal Lake (Wular and Dal are oxbow lakes of river Jhelum) are important from fisheries point of view as most of the fishing is carried out in these three water bodies (National Wetlands Atlas, 2011). The fish output is mostly confined to these three wetlands– out of the total fish produce, about 80 per cent is caught in Wular (Ramsar site) and Dal lakes and the rest in River Jhelum. The fish production from Kashmir Valley went up from 40480 quintal in 1965-66 to 161758 quintal in 2009-2010 (excluding trout production in government fish farms and carp production in private fish ponds) (Digest of Statistics, 2010-2011). The contribution of fisheries sector to Gross State Domestic Product and Agriculture State Domestic Product has increased from 0.4 and 1.0 in 1980-81 to 0.48 and 1.5 respectively. The Gross Value Added (GVA) from this sector at current prices for the year 2007-08 is estimated at Rs.227 crores as against Rs.207 crores during 2006-07 showing growth rate of 9.66%. The GVA from fisheries sector at Constant (1999-00) Prices in 2007-08 is estimated at Rs.119 crores as against Rs.118 crores during 2006-07 showing a growth rate of 0.85% (State Domestic Product of Jammu & Kashmir, 1999-00 to 2007-08).Valley offers potential for development of cold-water fisheries, hill stream fisheries, sport fisheries, reservoir fisheries, Mahseers fisheries, and ornamental fisheries. Besides these natural water resources possess enormous potential for development of varied types of trout fish (Rainbow trout, Brown trout & Kashmiri trout etc.). Given this potential, fisheries can play an important role in the economy of the state, as it will raise supply of animal protein and therefore will raise nutrition level, generate employment and earn foreign exchange (Economic Survey, 2007-08). The current study is undertaken with an aim to unearth the long run and short run relationships between fish production and determinants and try to understand if change in determinants over the years is going to have any ultimate impact on wetland fish production in Kashmir Valley.

2. LITERATURE REVIEW

The literature on the proposed theme is not as rich as very few studies emphasize on the relationship between fish production and determinants. However, a good number of studies are available on environmental and biological and physico-chemical factors affecting fisheries. The cited literature is based on previous empirical studies focusing on the relationship between fish production and determinants with varied outcomes.

Jan-Olaf Meynecke et al., (2006) in their study have used monthly rainfall; monthly temperature and monthly fish catch data to examine the effect of climate change on sustainable fish production. The economic impacts of climate change had been estimated by running regression model of fish catch over time on rainfall and temperature. Results indicated that up to 30% of Queensland's total fish catch and up to 80% of the barramundi (fish specie) catch variation for specific regions could be explained by rainfall often with a lagged response to rainfall events. The correlation analysis showed significant positive correlations between annual rainfall and total fish catch ($r = 0.54$; $P < 0.05$). Significant positive correlations also resulted from analysis between mean annual coastal rainfall and total annual commercial catches of mullet. Furthermore, regression analyses had been performed for rainfall and selected species groups, where the variation in model accounted for between 41% and 49% of the variation (r^2) in the catches of total mullet and barramundi. Baran E. et al., (2001) examined the relationship between fish production and hydrology of wetlands in the Mekong River Basin region. The authors applied logarithmic regression to study the relationship between annual catches and average water level in October in the floodplain river. They found very strong relationship between catch and water level and 92% ($r^2 = 0.92$) of the variation in dependent variable (catch in tons) was explained by the independent variable (average October water height in meters at the gauge). The model predicted that the catch will be nil if the October average water level does not exceed 5.1 m in the Lower Mekong River Basin. When examining the relationship between species-wise catch and the water level, it was found that the mostly dominant was Henicorhynchus sp. (comprising of fast-growing species believed to reach sexual maturity within only a year) whose abundance was highly correlated to the flood level. There was a slight and non-significant correlation between the catch and the water level one year before, and no correlation with previous years. Zarrien Ayub (2010) studied the effect of annual changes in fishing vessels, air temperature and rainfall on the catch of commercially important estuarine dependent fish and shrimp species of Pakistan by analyzing data from 1981 to 2006. The correlation between number of fishing vessels and fish caught during the period 1981 to 2006 showed a significant positive correlation ($r = 0.88$; $P < 0.01$). The correlation between the species of fish and shrimp and independent variables (temperature and rainfall) showed that in case of silver whiting annual catch and rainfall, a positive and marginally significant correlation ($r = 0.357$; $P < 0.10$, $n = 26$) was found. However, there was no significant correlation between annual rainfall and the catch of barramundi, Bombay duck, mullet, sardinella, anchovy, white shrimp and grey shrimp. The data for annual catch of Bombay duck, silver whiting, sardinella, anchovy, and grey shrimp showed no significant correlation with average annual temperature. However, there was significant negative correlation between average annual temperature and barramundi catch ($r = -0.526$; $P < 0.01$, $n = 23$) and positive correlation between average annual temperature and mullet catch ($r = 0.493$; $P < 0.05$, $n = 26$). There was a marginally significant correlation between average annual temperature and white shrimp catch. Ranta E. and Lindstroem K. (1993a) made a study on fourteen water quality variables of 166 northern Finnish lakes and their fish yield productivity. For most of the variables no clear covariation with the fish yield was found. However, authors found that fish yield tended to increase with increasing levels of oxygen saturation, conductivity, sodium (Na), pH and potassium (K) concentrations. A decreasing fish yield was observed with an increasing chemical oxygen demand (COD) of lake water and with increasing nitrogen (N). Intermediate levels of water color were associated with the highest fish yield. Ndebele-Murisa M. R. and et al., (2011) investigated the influence of climatic variables (rainfall, temperature and evaporation rates) and lake water levels on the stocks of the sardine fish species (Limnothrissa miodon) in Lake Kariba, Zimbabwe. A general linear regression model (GLRM) was used to analyze and investigate the relationships among fish catch (dependent variable) and the environmental factors (exploratory variables). The results of the estimated model showed that all the climatic factors as well as the water level significantly explain variations in the fish catches with the water level exerting the greatest influence in a negative manner ($R^2 = 0.84$, $P \leq 0.05$); followed by maximum temperature ($R^2 = 0.72$, $P \leq 0.05$), evaporation and rainfall. The R^2 of the model was 0.94 indicating that the combined effect accounted by of all the explanatory variables on Kapenta fish catches was 94%. Ranta E. and Lindstroem K., (1993b) in a study attempted to predict annual fish yield (kg/ha/yr) in a total of 390 lakes in Finland, using both water quality variables and variables involving fishing effort. Measures of fishing effort included gear numbers, gear type and number of fishermen. The results found that total fish yield could not be predicted reliably on the basis of water quality. At best, water quality explained no more than 15% of the variation in annual fish yield. Fishing effort turned out to be the most useful predictor, with an explanatory power of 50%. Debjit K. M. et al., (2010) in their study on two floodplain lakes of India attempted to evaluate changes between seasonal variation of water quality parameter and finfish diversity indices using quadratic regression analysis. It was found that in both floodplains the index of dominance of fish fauna was positively & significantly affected by depth and negatively & significantly by conductivity of water. M. Njiru et al., (2005) in their paper explored the impact of introductions of exotic fish species to the fishery of Lake Victoria. The authors found that catch composition of the lake has changed from those which prevailed at the inception of exotic species.

3. NEED/IMPORTANCE OF THE STUDY
The need of the study arises in the wake of current debate on climate change and its impact of natural resources having wide clears economic importance for human being across the world.

4. STATEMENT OF THE PROBLEM
This study highlights the impact of environmental factors on natural aquatic production functions and tries to explore the impact & possibility of existence of long-run relationship between fish production and economic & environmental factors in temperate valley of Kashmir, India.

5. OBJECTIVES
The overall objective of the study is to delineate the economic & environmental determinants of wetland fish production in the study area.

6. HYPOTHESES
H_{01}: There is no significant impact of fishing effort & environmental factors (such as water level, rainfall and atmospheric temperature) on the total wetland fish production in the study area.
H_{02}: There is no significant impact of fishing effort & environmental factors (such as water level, rainfall and atmospheric temperature) on the production of shizothorax and carp fish species in the study area.

7. RESEARCH METHODOLOGY
7.1. STUDY AREA
Strategically located Jammu & Kashmir State constitutes the northern most extremity of India, situated between 32.17°& 36.58° North latitude and 37.26° & 80.30° East latitude, the total area of the state is 22,22,236 sq. kms. including 78,114 sq. kms. under the occupation of Pakistan and 42,685 sq. kms. under that of China of which Pakistan handed over 5130 sq. kms to China. The state has three geographical zones and three distinct climatic regions viz, arctic cold desert areas of Ladakh, temperate Kashmir valley and sub-tropical region of Jammu (Hussain M., 2006).
7.2. DATA SOURCES
Data on Fish Production, Actual Number of Fishers, and Fish License-holder, and Fishing Boats were obtained from Statistical Digest of Jammu and Kashmir, 2009-2010, Directorate of Economics & Statistics, Srinagar (J&K) and www.indiastate.com (31/11/2012). Mean Annual Gauge Readings for Water Level of River Jhelum from 1965 to 2010 were collected from Irrigation & Flood Control Department (Floods (P&D) Division) Srinagar (J&K). The data for variable Mean Annual Rainfall were collected from Centre for Monitoring Indian Economy (CMIE). While the data for Mean Annual Temperature was compiled from Statistical Digest of Jammu and Kashmir, 2009-2010, Directorate of Economics & Statistics, Srinagar (J&K) & Meteorological Department Srinagar (J&K).
7.3.1. MODELS
The traditional Autoregressive Distributive Lag (ARDL) models developed by Banerjee A., et al. (1986) are appropriate for stationary data (stationary data is, in fact, a requirement of these models), however, such is not the case with modified Autoregressive Distributive Lag models (ARDL) developed and popularized by Pesaran and Shin (1995, 1998, 1999); Pesaran and Pesaran (1997); Pesaran and Smith (1998) and Pesaran et al. (1996, 2001). This technique has certain advantages over other co-integration approaches and can be applied for series having different orders of integration while same integration order is required for other co-integration approaches [Generalized Error Correction Models- ECM (Davidson et al., 1978), Autoregressive Distributed Lag Models- ARDL (Banerjee et

al., 1986), Engle–Granger Two-Step Static Method- EG (1987), Fully Modified OLS Procedure of Phillips and Hansen's (1990), Engle-Yoo Three-Step Modeling Method- EYM (Engle and Yoo, 1991), Maximum Likelihood-Based Johansen Approach- VAR Models (1988,1991) and Johansen-Juselius Method- Vector Error Correction Models- VECM (1990)] (Rao B. B., 2007). However, if a variable is integrated at I(2) then the computation of F-statistics for cointegration becomes inconclusive as Pesaran et al., (2001) critical bounds are based on the assumption that such variables should be stationary at I(0) or I(1). Thus, we apply unit root tests to ensure that no variable is integrated at I(2) or beyond. In addition, it is argued that the ARDL approach to cointegration gives better results for small sample data, as compared to other techniques. ARDL bounds testing approach is a new approach to the problem of testing the existence of a level (long-run) relationship between a dependent variable and a set of regressors, when it is not known with certainty whether the underlying regressors are trend (purely I(1)) or first-difference stationary (purely I(0)).

A three-stage procedure is used in estimating an ARDL model viz, testing the long-run relationship, estimating the long-run parameters and dynamic/ECM analysis. In the first stage of estimating the general equations, we investigate the existence of a long-run relationship predicted by theory among the variables in question. If a stable long-run relationship is supported by the first stage [F-tests are used for testing the existence of long-run relationships. The F-test has a non-standard distribution which depends upon: whether variables included in the ARDL model are to be I(0) or I(1); the number of regressors; and whether the ARDL model contains an intercept and/or a trend. Pesaran et al., (2001) discusses five cases with different restrictions on the trends and intercepts for F-test. The two sets of critical values for F-tests are reported in Pesaran M. H. and B. Pesaran (1997): one set is calculated assuming that all variables included in the ARDL model are I(1) and the other is estimated considering the variables are I(0). Critical values for I(1) series are called upper bound critical values and critical values for I(0) series are called lower bound critical values. If the computed F-values are greater than upper bounds critical values then the long run relationship among variables exists and if they are below the lower bounds critical values then no long run relationship exists among variables under consideration and if the F-values fall within the prescribed band then the result becomes inclusive. However, in this case, the error correction term will be a useful way of establishing cointegration. The null hypothesis for long run equilibrium is non-existence of long run relationship or no cointegration against alternative hypothesis of existence of long run relationship or cointegration.], then in the second stage, a further two-step procedure to estimate the model is carried out. In the first step of the second stage, the orders of the lags in the ARDL model are selected by Akaike Information Criteria (AIC) or Schwartz Bayesian Criteria (SBC). The incorporation of lagged values (t-1) is the best predictor of the series at time t because the effect of any shock is permanently incorporated into the memory of the model. In the second step of the second stage, the long-run parameters of the selected model are estimated by OLS and their significance testing is done. The general long-run ARDL cointegration equation representation is as follows:

$$\Delta Y_t = \ln \beta_0 + \sum_{i=1}^{p1} \beta_1 \Delta Y_{t-1} + \sum_{i=0}^{q1} \beta_2 \Delta X_{1t-1} + \sum_{i=0}^{q2} \beta_3 \Delta X_{2t-1} + \sum_{i=0}^{q3} \beta_4 \Delta X_{3t-1} + \sum_{i=0}^{q4} \beta_5 \Delta X_{4t-1} + \sum_{i=0}^{q5} \beta_6 \Delta X_{5t-1} + \beta_7 Y_{t-1} + \beta_8 X_{1t-1} + \beta_9 X_{2t-1} + \beta_{10} X_{3t-1} + \beta_{11} X_{4t-1} + \beta_{12} X_{5t-1} + U_t$$

In this equation, the terms with the summation signs capture the short-run dynamics of the model, whereas other terms represent the long-run relationship. Where p and q_1 …. q_5 are the optimal lag lengths and Δ is the first difference operator.

The third stage of analysis is the error correction model (ECM). When there is a long-run relationship between the variables then there exists an error correction representation. Error Correction Model can connect the short-run variations of variables to their long-run values. In order to set an ECM model besides other variables, the first difference of the variables involved is also taken into consideration and we need to consider the residuals of cointegration equation with a lag as an explanatory variable and finally estimate the model coefficients using OLS. We know that that the ARDL model provides information similar to the ECM and we can derive a single equation ECM from a general ARDL model. Infact, certain forms of ARDL models are isophormic to error correction models. The ARDL model like ECM model estimates short-run and long-run coefficients and also gives coefficient for error correction term ECM(-1) which is our ECM. The error correction term ECM(-1) indicates the deviation in dependent variable for a short span of time to the long-run equilibrium path. The coefficient of ECM tells us how much of the disequilibrium in the system due to some shocks is rectified in the long run or it shows how sooner or later or how slowly/quickly variable returns to equilibrium and it should have a negative sign. Thus the coefficient of error correction term represents the speed of adjustment to restore equilibrium in the dynamic model following a disturbance. Banerjee et al., (1998) holds that a highly significant error correction term is further proof of the existence of a stable long run relationship. Infact, ARDL approach simultaneously provides the long run and short run estimates for empirical investigation. This technique provides an efficient way to separately examine the long run and short run causal relationships. The following equation is the general error correction model (ECM) representation:

$$\Delta Y_t = \ln \beta_0 + \sum_{i=1}^{p1} \beta_1 \Delta Y_{t-1} + \sum_{i=0}^{q1} \beta_2 \Delta X_{1t-1} + \sum_{i=0}^{q2} \beta_3 \Delta X_{2t-1} + \sum_{i=0}^{q3} \beta_4 \Delta X_{3t-1} + \sum_{i=0}^{q4} \beta_5 \Delta X_{4t-1} + \sum_{i=0}^{q5} \beta_6 \Delta X_{5t-1} + \beta_7 EC_{t-1} + U_t$$

where β_7 is the speed-of-adjustment parameter and EC_{t-1} represents the residuals that are obtained from the estimated long-run (cointegration) model.

7.3.2. ELABORATION OF ECONOMETRIC MODELS AND VARIABLES USED

Model 1: Determinants of Wetland Fish Production

The Cobb-Douglas production function model specified to estimate the factors affecting wetland fish production in Kashmir Valley is as follows:

$$FP_t = f\left(\beta_0 FP_{t-1}^{\beta 1} AF_t^{\beta 2} FB_t^{\beta 3} MAR_t^{\beta 4} MAWLW_t^{\beta 5} MAT_t^{\beta 6} U_{1t}\right)$$

By taking the logarithm of above =n, we can obtain the least-squares estimates of the parameters there. Thus,

$$\ln FP_t = \ln \beta_0 + \beta_1 \ln FP_{t-1} + \beta_2 \ln AF_t + \beta_3 \ln FB_t + \beta_4 \ln MAR_t + \beta_5 \ln MAWLW_t + \beta_6 \ln MAT_t + U_{1t}$$

Theoretical Justification of Various Variables Included in the Model:

$\ln FP_t$ = Natural log of fish catch/production in time period t,

$\ln FP_{t-1}$ = Natural log of fish catch/production in time period t-1: Fish stock change depends on biological factors such as recruitment, natural mortality, individual growth and natural factors such as water temperature, water density, water quality/pollution levels, food supplies, natural predation etc. and anthropogenic factors such as fish harvesting. Since data on recruitment, individual growth, natural mortality & water temperature, water density, water quality/pollution levels, food supplies, natural predation of fishes is not available and all these are governed by biology/nature and are difficult to measure and include in the model, therefore, all these biological & natural factors are taken care by the error term 'U_t'in the model. So any change in fish stock levels are directly affected by fish harvesting (through effort) over a period of time. Thus the stock change can be positive or negative if natural growth rate is greater or smaller than harvest rate respectively. When a stock is depleted i.e., when harvest is greater than growth, fish stock becomes a decreasing function of fishing effort, catch reductions are in order, but typically they are implemented only after considerable delay. Similarly, when fish catch/harvest is reduced (through lower effort) fish stocks recover and lead to higher catches/harvest but typically only after considerable delay (D. S. Huang and C. W. Lee, 1976). Generally speaking, fishing effort affects the fish stock which in turn affects fish catch/harvest. Thus, today's catch will affect tomorrow's catch. So it is catch/harvest itself which indicates the status of stock and affects itself though with delay. Therefore, introduction of the lagged value of dependent variable ($\ln FP_{t-1}$) as an explanatory variable captures the influence of stock on harvest/catch. In general, lag of the dependent variable as explanatory variable identifies the time delay in response of dependent variable to the known lagged predetermined variable, i.e., observations at 't' are likely to be correlated with observations at 't_{-1}', 't_{-2}' and so forth.

lnAF_t = Natural log of No. of actual fishers in time period t: It is the number of fishers who actually indulge in fishing (Since fishermen indulging in fishing do not all subscribe to license and many of them take to fishing illegally and those who subscribe to license do not all indulge in fishing but they do so to make other occupation related benefits) as such it is an important variable influencing the fish production. The coefficient (β_2) of lnAF_t measures the rate of change in fish production with respect to rate of change in actual number of fishers. The higher the rate of participation in fishing higher will be the fish exploitation rate and greater the fish production in short run and vice-versa. But in the long-run irreversible changes may result due to overexploitation problem (This is because under normal circumstances most of the households participating in fishing do so in the same fishery.) which is often the destiny of most of the aquatic common property resources.

lnFB_t = Natural log of No. of fishing boats in time period t: The coefficient (β_3) of lnFB_t measures the rate of change in fish production with respect to the rate of change in fishing boats (capital) or in other words it measures the rate of change in fish production with respect to the rate of growth of capital. A higher coefficient on the natural log of number of fishing boats shows that the fish production function is capital intensive.

lnMAR_t = Natural log of mean annual rainfall in millimeters in the study area in time period t: The coefficient (β_4) of lnMAR_t measures the rate of change in fish production with respect to the rate of change in the mean annual rainfall in the study area. The speculation that climate change may impact on sustainable fish production through variation in rainfall suggests a need to understand how these effects influence fish production of temperate wetlands. Therefore, an attempt has been made to study relationship between rainfall and fish production. The main objective is to find out impact, if there is any, of rainfall variation on the wetland fish production.

ln$MAWLW_t$ = Natural log of mean annual water level of the wetlands in meters in the study area in time period t: The coefficient (β_5) of ln$MAWLW_t$ measures the rate of change of fish production with respect to the rate of change in the mean annual water level of the wetlands. Water level, total inflow and outflow, stored water content and water quality of a wetland are the important environmental factors that affect all the other environmental characteristics of freshwater ecosystems. The increased water level is likely to have positive impact on certain fish species production while as decreased water level due to siltation, encroachment, erratic & scarce rainfall and snowfall will have negative impact on certain fish species production. Therefore for the present study the water level of Jhelum River (since it connects both the wetlands- Wular and Dal or in other words Wular and Dal are oxbow lakes of river Jhelum and influences their hydrology and biota) is taken into consideration. The daily gauge readings of River Jhelum at thirty three sites viz, Khannabal, Sangam, Kaipora, Dogripora, Awantipora, Kandizaal, Pampore, Sempora, Batwara, Padshahi Bagh, Sonwar, Munshi Bagh, Badshah Bridge, Habba Kadal, Fateh Kadal, Zaina Kadal, Nawa Kadal, Safa kadal, Chattabal U/S, Chattabal Main, Chattabal D/S, Shadipora, Asham, Baniyari, Gulamyari, Ningli on Wular, Sopore, Seer, Doabgah, Delina, Baramulla, Khanpora, Khadinyar etc., is collected by Irrigation & Flood Control Department (Floods (P&D) Division) Srinagar. Of these thirty three sites, the water level data for five sites viz Khannabal, Sangam, Munshi Bagh, Asham & Sopore are most important as the data of these five sites is submitted to the Central Water Commission, Ministry of Water Resources, Government of India and Indus Water Treaty cell, is used in the analysis.

lnMAT_t = Natural log of mean annual atmospheric temperature in degrees Celsius in the study area in time period t: The coefficient (β_5) of lnMAT_t measures the rate of change of fish production with respect to the rate of change in the mean annual atmospheric temperature. The meteorological factors such as temperature, sunshine, rainfall, humidity exert a considerable influence on the physicochemical dynamics of water body which in turn largely determines the structure and composition of biotic community of an aquatic ecosystem. While as weather directly affects fishing climate variability determines the distribution, species composition, and abundance of fish particularly in temperate regions. Climate change impacts on inland aquatic ecosystems will range from the direct effects of the rise in temperature to indirect effects through alterations in the hydrology resulting from the changes in the regional precipitation regimes and the melting of glaciers and ice cover. Since fish population variability is closely linked to climate dynamics. It is therefore necessary to understand to what extent climate changes are affecting fish stocks and therefore fish catch/production. In order to be able to explain the impacts of temperature changes on the future state of fisheries the mean annual temperature has been introduced in the model. (Lehodey P., 2006) states that if close link between climate and fisheries is to be explained then it is best illustrated by the effect of annual temperature variation on non-seasonal (interannual) fish production. The importance of temperature is evident at spatial scales as fish species often are grouped according to local temperature. Cold water species typically have physiological optima ≤ 20-25°C and generally are not found where summer temperatures are > 25°C. Trout and salmon (family salmonidae), Cyprininae Schizothoracine are the dominant cold water species of high elevation aquatic systems throughout north India and are of prime importance for both recreational and commercial fisheries.

β_0 = Intercept in the regression model,

U_{1t} = Stochastic error term which capture the random variation of the production function across 't', and captures the effects of measurement errors, and exogenous shocks which are beyond the control of the modeler.

Model 2: Determinants of Shizothorax Fish Specie Production of Kashmir Wetlands

Specification of the Model:

$$\ln SF_t = \ln \alpha_0 + \alpha_1 \ln SF_{t-1} + \alpha_2 \ln CF_{t-1} + \alpha_3 \ln AF_t + \alpha_4 \ln FB_t + \alpha_5 \ln MAR_t + \alpha_6 \ln MAWLW_t + \alpha_7 \ln MAT_t + U_{2t}$$

Theoretical Justification of Various Variables Included in the Model:

lnSF_t = Natural log of fish catch/production of shizothorax specie in time period t,

lnSF_{t-1} = Natural log of fish catch/production of shizothorax specie in time period t-1: It is the lagged catch of shizothorax fish specie (lagged endogenous variable with a lag of one time period). The catch of shizothorax fish specie depends on the size and composition of the fish stock (natural resource) which itself comprises of stock of shizothorax fish specie & stock of carp fish specie (two principal species of Kashmir wetlands) and of course several other species which are caught in negligible quantities. Since the catch of shizothorax fish specie depends itself on stock of specie (shizothorax specie) which in turn is governed by biological and anthropogenic factors such as fish harvesting therefore, any change in catch of shizothorax specie affects stock level of specie directly which in turn affects the catch of specie. So specie catch can increase (or decrease) if natural growth rate is greater (or smaller) than harvest/catch rate of the specie. When specie stock is depleted i.e., when harvest/catch rate is greater than natural growth rate of specie, catch becomes a decreasing function of catch itself but typically is implemented only after delay. Thus, today's catch will affect tomorrow's catch. This phenomenon is captured by the lagged value of dependent variable lnSF_{t-1} as an explanatory variable in the regression model.

lnCF_{t-1} = Natural log of fish catch/production of carp specie in time period t-1: This specie was introduced in Kashmir wetlands in 1956 and since then has invaded all waters of the valley. It is being said (fishermen opinion) that introduction of this species has led to fall in the catch of shizothorax specie (a native fish) may be due to competition for food, space or due to predation or mutation etc. In order to capture its impact on shizothorax specie the lagged catch of carp fish specie has been introduced as an explanatory variable in the model.

lnAF_t = Natural log of No. of actual fishers in time period t,

lnFB_t = Natural log of No. of fishing boats in time period t,

lnMAR_t = Natural log of mean annual rainfall in millimeters in the study area in time period t,

ln$MAWLW_t$ = Natural log of mean annual water level of the wetlands in meters in the study area in time period t,

lnMAT_t = Natural log of mean annual atmospheric temperature in degrees Celsius in the study area in time period t,

α_0 = Intercept in the regression model,

α_1 ………. α_7 = Coefficients to be estimated,

U_{2t} = Stochastic error term in model 2,

Model 3: Determinants of Carp Fish Specie Production of Kashmir Wetlands

Specification of the Model:

$$\ln CF_t = \ln \gamma_0 + \gamma_1 \ln CF_{t-1} + \gamma_2 \ln SF_{t-1} + \gamma_3 \ln AF_t + \gamma_4 \ln FB_t + \gamma_5 \ln MAR_t + \gamma_6 \ln MAWLW_t + \gamma_7 \ln MAT_t + U_{3t}$$

Theoretical Justification of Various Variables Included in the Model:

$lnCF_t$ = Natural log of fish catch/production of carp specie in time period t,

$lnCF_{t-1}$ = Natural log of fish catch/production of carp specie in time period t-1,

$lnSF_{t-1}$ = Natural log of fish catch/production of shizothorax specie in time period t-1: This is the native specie of Kashmir wetlands and in order to capture its impact on carp specie (exotic specie) the lagged catch of shizothorax fish specie has been introduced as an explanatory variable in the model.

$lnAF_t$ = Natural log of No. of actual fishers in time period t,

$lnFB_t$ = Natural log of No. of fishing boats in time period t,

$lnMAR_t$ = Natural log of mean annual rainfall in millimeters in the study area in time period t,

$lnMAWLW_t$ = Natural log of mean annual water level of the wetlands in meters in the study area in time period t,

$lnMAT_t$ = Natural log of mean annual atmospheric temperature in degrees Celsius in the study area in time period t,

γ_0 = Intercept in the regression model,

γ_1 ……… γ_7 = Coefficients to be estimated,

U_{3t} = Stochastic error term in model 3,

8. RESULTS, DISCUSSION & FINDINGS

8.1. UNIT ROOT & COINTEGRATION TEST RESULTS

To avoid the spurious regressions stationarity of the time series variables used in three models was checked and it was found that variables involved are differently cointegrated as some are I(0) while others are I(1) but none is I(2). Therefore it was decided to use ARDL bounds test approach to estimate the above mentioned models.

TABLE 8.1: THE ADF UNIT ROOT TEST FOR NON-STATIONARITY WITH TREND & INTERCEPT

Variables	ADF Test At Level	Prob.	Results Status	ADF Test At First Difference	Prob.	Results Status
$lnFP_t$	0.336193	0.9983	I(1)	-7.346132	0.0000*	I(0)
$lnSF_t$	-3.870705	0.0216***	I(0)	-17.51826	0.0000	I(0)
$lnCF_t$	-0.267445	0.9892*	I(1)	-6.651703	0.0000	I(0)
$lnAF_t$	-2.083186	0.5408	I(1)	-4.000613	0.0164**	I(0)
$lnFB_t$	-3.376554	0.0674	I(1)	-5.264832	0.0005***	I(0)
$lnMAWLW_t$	-4.165704	0.0103**	I(0)	-8.564938	0.0000	I(0)
$lnMAT_t$	-4.320491	0.0068*	I(0)	-6.583976	0.0000	I(0)
$lnMAR_t$	-6.028021	0.0000*	I(0)	-8.062981	0.0000	I(0)

*Significant at 1%; ** Significant at 5%; *** Significant at 10%

In order to confirm the long-run relationship between variables for three models, we used Wald statistics based on Pessaren's bounds test. Given the limited number of observations (46) and the use of annual data we take p =3, i.e., the number of lags is three. The calculated F- statistics for model- 1 is 4.113161, which is higher than the upper bounds critical value of 3.79 at 10% sig. level with unrestricted intercept & trend for five regressors. While the calculated F- statistics for the model- 2 is 4.103139, which is higher than the upper bounds critical value of 4.00 at 5% sig. level with unrestricted intercept & trend for six regressors. And the calculated F- statistics for the model- 3 is 3.604364, which is higher than the upper bounds critical value of 3.59 at 10% sig. level with unrestricted intercept & trend for six regressors. The results are depicted in table 8.2.

TABLE 8.2: COINTEGRATION TEST RESULTS FOR MODELS 1, 2 & 3 WITH UNRESTRICTED INTERCEPT & TREND

Model	Wald Sta.	Prob.	No. of Regressors	Upper Bounds Critical Value	Lower Bounds Critical Value
Model - 1	4.113161	10%	5	3.79	2.75
Model - 2	4.103139	5%	6	4.00	2.87
Model - 3	3.604364	10%	6	3.59	2.53

8.2. EMPIRICAL RESULTS AND DISCUSSIONS

TABLE 8.2.1: ESTIMATED LONG RUN COEFFICIENTS FOR MODEL 1 ARDL (3,0,0,0,1,0) BASED ON SBC

Dependent variable is $lnFP_t$ (43 observations used for estimation from 1968 to 2010)			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$lnAF_t$	-.055208	.024793	-2.2267[.033]
$lnFB_t$	.82061	.091683	8.9505[.000]
$lnMAR_t$	-.0038868	.081575	-.047646[.962]
$lnMAWLW_t$	.090974	.22855	.39805[.693]
$lnMAT_t$	.36467	.30401	1.1995[.239]
INPT	2.4377	1.4301	1.7046[.098]

In estimating the long-run relationship for model 1, a maximum of three lags was used and the model was selected based on SBC along with trend and intercept. However, the trend was found insignificant and was dropped and model was re-estimated and the results shown in table 8.2.1 were found. The empirical results of the long-run model show that natural log of actual number of actual fishers ($lnAF_t$) has statistically significant effect on natural log of fish production ($lnFP_t$) at 5% significant level. The negative sign and magnitude of the variable depict that as number of actual fishermen increases by 1% the fish production decreases by about 5.5%, other things being equal. The result is also endorsed by earlier study like (D. S. Huang and C. W. Lee, 1976). The finding has direct implications for wetland fisheries problems in Valley. It denotes that wetland fisheries sector in Kashmir valley is congested and any further increase in the number of fishermen will deplete fish stocks and therefore will translate into poor catches (falling average and marginal catch rates) which will further translate into poverty of fishers. It is thus clear that if this problem is not solved immediately, the fish production in Kashmir wetlands' will fall. This will have serious repercussions not only on fishermen but on the fishing sector as a whole as well as wetlands' biodiversity. Therefore, the department of fisheries should reduce the fishing licenses by restricting the issuance of licenses to traditional fishers only and strictly ban illegal fishing to make fishing occupation sustainable. On the other hand, the fishing boats estimate indicates that a 1% increase in fishing boats ($lnFB_t$) results in an increase of fish production by about 82%. The result is also endorsed by earlier studies like Ranta E. and Lindstroem K. (1993b) and Zarrien Ayub (2010). The result provides guidelines for the improvement of fish production by increasing the number of fishing boats. Since inland fishing is traditional in nature and is capital deficient (uses relatively less capital) compared to marine fishing sector therefore there is ample space for introduction of motor boats and modern fishing nets. Thus instead of increasing the number of fishing boats (by issuing more fishing licenses) it is recommended to reduce licenses and introduce motor boats and modern fishing instrument to increase wetland fish production and therefore income of traditional fishermen community. The long-run results for mean annual rainfall, mean annual water level of the wetland, and mean annual atmospheric temperature did not have any significant impact on total wetland fish production in the study area. However, it does not mean that these explanatory variables do not have any impact on individual species comprising our total fish production. The intercept turned significant at 10% level of significance.

TABLE: 8.2.2: ERROR CORRECTION REPRESENTATION FOR MODEL 1 ARDL(3,0,0,0,1,0) BASED ON SBC

Dependent variable is $dlnFP_t$ (43 observations used for estimation from 1968 to 2010)			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$dlnFP_t(-1)$	-.61058	.13081	-4.6677[.000]
$dlnFP_t(-2)$	-.57365	.13340	-4.3003[.000]
$dlnAF_t$	-.017770	.0091913	-1.9334[.062]
$dlnFB_t$	.26414	.085780	3.0792[.004]
$dlnMAR_t$	-.0012511	.026197	-.047757[.962]
$dlnMAWLW_t$	-.099237	.058630	-1.6926[.100]
$dlnMAT_t$	.11738	.10809	1.0859[.285]
dINPT	.78464	.47610	1.6481[.109]
ecm(-1)	-.32188	.094292	-3.4136[.002]

Error correction representation is reported in table 8.2.2. Δ sign and coefficient express the short-run elasticity of the variables used in the model. The results of table 8.2.2, reveal the importance of fish stock in determining the fish production- a 1% increase in one-period lag fish production decreases current period fish production by 61%. This clearly reflects the negative effect of harvesting fishery resources at a rate more than their renewal (growth) rate in the short-run. Similarly, a 1% increase in two-period lag fish production decreases current period fish production by 57%. The relationship between previous period catches and current period catch in the short-run confirms that when the targeted fish begins to decrease in short-run because of over-fishing, the fishing activity is reduced in response to the necessity of increasing effort for smaller returns which leads to restoration of fish stock over long-run. The coefficient of natural log of actual number of fishers is negative and is significant at 5% level. This further confirms the negative effect of actual number of fishers on fish production even in short-run- the severe competition among fishers on a fishery for fixed fish stock leads to fall in fish catch. However, the natural log of fishing boats has negative effect on fish production in the short-run and is significant at 1% level and a 1% increase in fishing boats leads to 26% decrease in fish production. Lastly, mean annual water level of the wetland affects annual fish production in the short-run with the significant elasticity of 0.099 at the 10% level indicating that a 1% increases in mean annual water level of the wetland decreases the fish production by 10%. It is because search cost (in terms of labour and time) increases with increase in water level of the wetland in the short. The result for water level is contradictory to results of Baran E. et al., (2001) but in tune with the results of Ndebele-Murisa M. R. and et al., (2011).The error correction term ecm(-1) which measures the speed of adjustment to restore equilibrium in the dynamic model, appears with a negative sign and is statistically significant at less than 1% level ensuring that the series is non-explosive, and confirms that a long-run relationship exists between the variables in model 1. The coefficient of -0.32188 implies that only 32% of the disequilibrium in fish production from the previous period's shock will converge back to the long-run equilibrium in the current period.

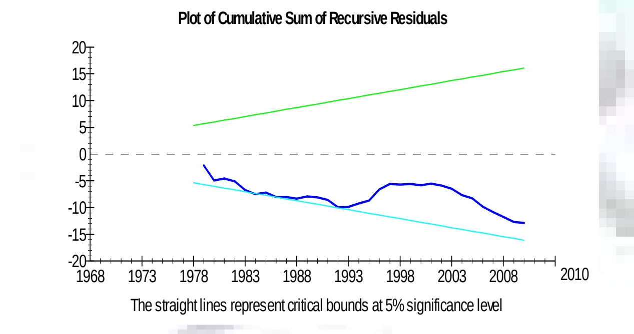
TABLE 8.2.3: GOODNESS OF FIT & DIAGNOSTIC TESTS FOR MODEL 1

R-Squared: 0.99275	R-Bar-Squared: 0.99077
F- statistic: $F(9, 33)$ 502.0868 [.000]	DW-statistic: 2.2741
σ of Regression: 0.036810	Breusch-Godfrey test: $\chi^2(1)$= 2.0319 [.154]
Ramsey's RESET test: $\chi^2(1)$= .022382 [.881]	Jarque-Bera test: $\chi^2(2)$= 2.6162 [.270]
Engle's ARCH LM test: $\chi^2(1)$ = 7.4023 [.007]	

Apart from the high significance levels of variables and the existence of a long-run relationship, our model is statistically well behaved. We applied a number of diagnostic tests to model 1, such as Breusch-Godfrey or Lagrange Multiplier test of Residual Serial Correlation and found no evidence of autocorrelation in the disturbance term. The evidence of no auto-correlation was further confirmed by the value of diagnostic test, D.W. Statistic 2.2741. The Engle's ARCH LM test of Heteroscedasticity suggests that the errors are homoscedastic and independent of the regressors. The model passes the Jarque-Bera test of Normality suggesting that the errors are normally distributed. The Ramsey's RESET test of Functional Form indicates that the model is correctly specified. While the adjusted R^2 of the model is high implying an excellent fit of the model- 99% of the variation in the fish production is explained by the regressors. In addition, the F-statistic is significant at less than 1% level expressing that the model has an overall good fit.

For stability of model 1 (parameter stability), we test the model by cumulative sum of residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) tests also known as Brown et al. (1975) stability testing technique. It was found that model is stable (short run and long run coefficients in the ARDL/ECM are stable) as neither CUSUM nor CUSUMSQ tests exceed the lower and upper bounds of 5% level of significance. Therefore the null hypothesis of all coefficients in the given regression model are stable cannot be rejected.

THE GRAPH OF CUSUM & CUSUMSQ FOR MODEL 1 IS SHOWN IN FIG. 8.2.1



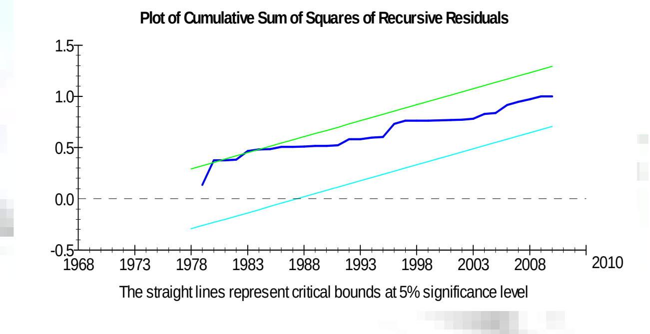


TABLE 8.2.4: ESTIMATED LONG RUN COEFFICIENTS FOR MODEL 2 ARDL(0,2,1,0,0,0,0) BASED ON SBC

Dependent variable is $lnSF_t$ (43 observations used for estimation from 1968 to 2010)			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$lnCF_t$	.62771	.079185	7.9271[.000]
$lnAF_t$	.0018487	.0083533	.22131[.826]
$lnFB_t$	.018042	.079571	.22675[.822]
$lnMAR_t$	.4900E-3	.023440	.020906[.983]
$lnMAWLW_t$	.0074828	.049835	.15015[.882]
$lnMAT_t$	-.15960	.094387	-1.6909[.100]
INPT	2.7295	.38504	7.0888[.000]

The empirical results of the long-run relationship for model 8.2.4, show that natural log of fish catch/production of carp specie ($lnCF_t$) has statistically significant effect on natural log of fish catch/production of shizothorax specie ($lnSF_t$) at less than 1% significant level. The positive sign and magnitude of the variable depicts that introduction of the carp specie into Kashmir wetlands has favorably affected the native specie (Shizothorax) as the fish catch/production of carp specie increases by 1% the catch of shizothorax specie increases by about 63%, all other things being equal. The result is contrary to the result found by M. Njiru et al. (2005). Therefore, introduction of carp specie into Kashmir wetlands was a right decision undertaken by fisheries experts. The finding has a solution for under stocked water bodies in Valley and provides guidelines for the improvement of fish production. The fisheries department with the help of fisheries experts should introduce new prized species which are fast growing in nature to increase fish production and raise economy of the state. The coefficient of natural log of mean annual atmospheric temperature is negative and is significant at 10% level. This shows the negative impact of climate change on cold water fishes such as Shizothorax in the temperate wetlands. As the mean annual temperature increases by 1%, the Shizothorax fish production decreases by about 16 percent. The intercept is significant at less than 1% significance level.

TABLE 8.2.5: ERROR CORRECTION REPRESENTATION FOR MODEL 2 ARDL(0,2,1,0,0,0,0) BASED ON SBC

Dependent variable is $dlnSF_t$ (43 observations used for estimation from 1968 to 2010)			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$dlnCF_t$	.29067	.099600	2.9184[.006]
$dlnCF_t(-1)$	-.28534	.094150	-3.0307[.005]
$dlnAF_t$	.028572	.012509	2.2841[.029]
$dlnFB_t$	.018042	.079571	.22675[.822]
$dlnMAR_t$	.4900E-3	.023440	.020906[.983]
$dlnMAWLW_t$	.0074828	.049835	.15015[.882]
$dlnMAT_t$	-.15960	.094387	-1.6909[.100]
dINPT	2.7295	.38504	7.0888[.000]
ecm(-1)	-1.0000	0.00	*NONE*

Error correction representation for model 2 is reported in table 8.2.5. The results reveal the importance of carp fish stock in determining the shizothorax fish production- a 1% increase in current period carp fish production increases current period Shizothorax fish production by 29%. However, a 1% increase in one-period lag carp fish production decreases current period Shizothorax fish production by about 29%. This clearly reflects relationship between previous period carp catch and current period Shizothorax catch in the short-run and confirms that the two species have mutually benefitted each other. Similarly, a 1% increase in actual number of fishers increases the shizothorax production by about 29%. The negative sign of the coefficient of natural log of mean annual atmospheric temperature shows that a 1% increases in atmospheric temperature decreases Shizothorax fish production by 16% even in the short-run. The intercept is significant at less than 1% significance level. The error correction term ecm(-1) for model 2 appears with a negative sign and is statistically significant at less than 1% level. The coefficient of -1.0000 implies that 100 per cent of the disequilibrium in Shizothorax fish production from the previous period's shock will converge back to the long-run equilibrium in the current period.

TABLE 8.2.6: GOODNESS OF FIT & DIAGNOSTIC TESTS FOR MODEL 2

R-Squared: 0.98978	R-Bar-Squared: 0.98700
F- statistic: F(9, 33) 355.1720[.000]	DW-statistic: 1.9466
σ of Regression: 0.032552	Breusch-Godfrey test: $\chi^2(1)$= .025712 [.873]
Ramsey's RESET test: $\chi^2(1)$= 3.0089[.083]	Jarque-Bera test: $\chi^2(2)$= 22.6531[.000]
Engle's ARCH LM test: $\chi^2(1)$ = 2.3822[.123]	

Apart from the high significance levels of variables and the existence of a long-run relationship, our model is statistically well behaved. We applied a number of diagnostic tests to model 2, the overall health of the model is fine. However, it fails to pass the Jarque-Bera test of Normality suggesting that the errors are not normally distributed. The Ramsey's RESET test of Functional Form indicates that the model is not correctly specified but functional form is not a big issue in ARDL modeling Approach. While the adjusted R^2 of the model is high implying an excellent fit of the model- about 99% of the variation in the fish production is explained by the regressors. In addition, the F-statistic is significant at less than 1% level expressing that the model has an overall good fit.

For stability of model 2 (parameter stability), we test the model by cumulative sum of residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) tests. It was found that model is stable (short run and long run coefficients in the ARDL/ECM are stable) although CUSUMSQ test crosses the upper bounds of 5% level of significance may be due to non-normality of error terms.

THE GRAPH OF CUSUM & CUSUMSQ FOR MODEL 1 IS SHOWN IN FIG. 8.2.2

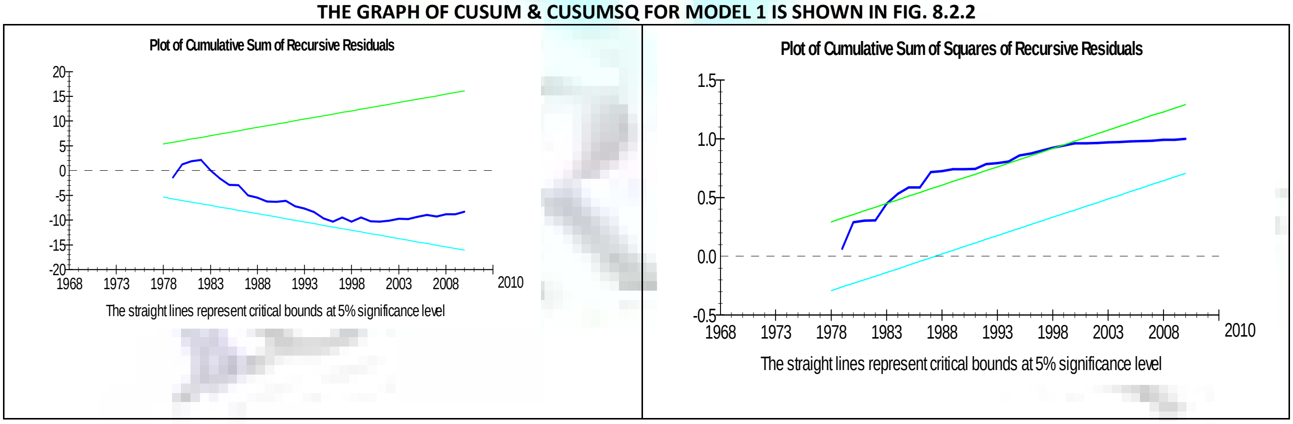


TABLE 8.2.7: ESTIMATED LONG RUN COEFFICIENTS FOR MODEL 3 ARDL(0,3,1,3,2,3,3) BASED ON SBC

Dependent variable is $lnCF_t$ (43 observations used for estimation from 1968 to 2010)			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$lnSF_t$	1.9803	.23831	8.3097[.000]
$lnAF_t$	-.049632	.011700	-4.2421[.000]
$lnFB_t$	-1.2150	.23290	-5.2169[.000]
$lnMAR_t$	-.18628	.033860	-5.5014[.000]
$lnMAWLW_t$	.021031	.071654	.29351[.772]
$lnMAT_t$	-.97924	.21221	-4.6145[.000]
INPT	5.9286	1.2992	4.5631[.000]
T	.029923	.0040886	7.3185[.000]

The empirical results of the long-run relationship for model 3 shown in table 8.2.7, indicate that natural log of fish catch/production of shizothorax specie ($lnSF_t$) has statistically significant effect on natural log of fish catch/production of carp specie ($lnCF_t$) at less than 1% significant level. The positive sign and magnitude of the variable depicts that as the shizothorax (native specie) fish catch/production increases by 1% the catch of carp specie increases by about 198%, all other things being equal. However, a 1% increase in actual number of fishers decreases the carp production by about 5%. While a 1% increase in fishing boats decreases carp production by about 122%. The negative sign of the coefficient of natural log of mean annual rainfall shows that a 1% increases in mean annual rainfall decreases carp fish production by about 19%. The results of rainfall are in contrast to the results found by Jan-Olaf Meynecke et al., (2006). The sign of the coefficient for natural log of mean annual atmospheric temperature shows detrimental impact of climatic change on carp fish specie in temperate wetlands. The magnitude of the coefficient of the variable indicates that a 1% increase in annual atmospheric temperature reduces carp production by about 98%. Both the intercept and Trend are significant at less than 1% significance level.

TABLE 8.2.8: ERROR CORRECTION REPRESENTATION FOR MODEL 3 ARDL(0,3,1,3,2,3,3) BASED ON SBC

Dependent variable is $dlnCF_t$ (43 observations used for estimation from 1968 to 2010)			
Regressor	Coefficient	Standard Error	T-Ratio[Prob]
$dlnSF_t$	.61013	.15155	4.0259[.000]
$dlnSF_t(-1)$	-1.1428	.13091	-8.7296[.000]
$dlnSF_t(-2)$	-.53418	.067444	-7.9203[.000]
$dlnAF_t$	-.017246	.012459	-1.3842[.179]
$dlnFB_t$	-.10071	.10780	-.93418[.359]
$dlnFB_t(-1)$	.68149	.11297	6.0327[.000]
$dlnFB_t(-2)$	.57346	.082549	6.9470[.000]
$dlnMAR_t$	.012568	.023758	.52902[.601]
$dlnMAR_t(-1)$	.088171	.022742	3.8770[.001]
$dlnMAWLW_t$	-.034221	.048026	-.71254[.483]
$dlnMAWLW_t(-1)$	.14227	.051452	2.7650[.011]
$dlnMAWLW_t(-2)$	.084754	.047635	1.7792[.087]
$dlnMAT_t$	-.19213	.080440	-2.3885[.025]
$dlnMAT_t(-1)$	.72473	.13849	5.2330[.000]
$dlnMAT_t(-2)$	.64426	.13242	4.8654[.000]
dINPT	5.9286	1.2992	4.5631[.000]
dT	.029923	.0040886	7.3185[.000]
ecm(-1)	-1.0000	0.00	*NONE*

Error correction representation for model 3 is reported in table 8.2.8. The results reveal the importance of shizothorax fish stock in determining the carp fish production- a 1% increase in current period shizothorax fish production increases current period carp fish production by 61%. However, a 1% increase in one-period & two-period lags shizothorax fish production decreases current period carp fish production by about 114% and 53% respectively. This clearly reflects relationship between previous period's shizothorax catch and current period carp catch in the short-run and confirms that the two species have mutually benefitted each other. The coefficient of natural log of fishing boats is significant at less than 1% level and shows that a 1% increase in one-period and two-period lags of number of fishing boats increases carp production by 68% and 53% respectively. Similarly, a 1% increase in one-period lag mean annual rainfall decreases current period carp fish production by about 9%. While the coefficient of one-period lag mean annual water level of the wetlands is significant at 1% level and indicates that a 1% in previous period's water level of wetland increases carp production by 14%. Similarly, two-period lag water level is significant at 10% level and a 1% increase in two period lag water level increases carp production by 8%. The results for water level of wetland are in accordance with results found by Baran E. et al., (2001) and Ndebele-Murisa M. R. and et al., (2011). The impact of the natural log of mean annual atmospheric temperature on carp production is mixed. While the sign and magnitude of the current-period mean annual atmospheric temperature shows that a 1% increase in mean annual atmospheric temperature decreases carp fish production by 19%, the one-period lag shows that a 1% increase in mean annual atmospheric temperature increases carp production by 72% and is significant at less than 1% level. Similarly, a two-period lag in natural log of mean annual atmospheric temperature shows that a 1% increase in air temperature increases carp production by 64% and is significant at less than 1% level. Thus, although the impact of mean annual air temperature on overall fish production is insignificant but effect on individual species is significant and detrimental both in the long-run as well as short-run. Both trend and intercept have turned significant at less than 1% significance level. The error correction term ecm (-1) for model 3 appears with a negative sign and is statistically significant at less than 1% level. The coefficient of -1.0000 implies that 100 per cent of the disequilibrium in carp fish production from the previous period's shock will converge back to the long-run equilibrium in the current period.

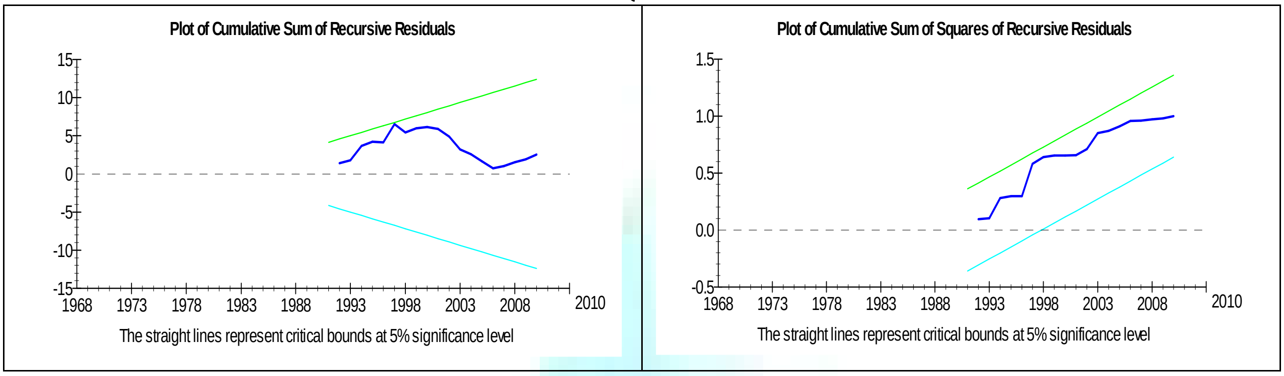
TABLE 8.2.9: GOODNESS OF FIT & DIAGNOSTIC TESTS FOR MODEL 3

R-Squared: 0.99864	R-Bar-Squared: 0.99714
F- statistic: F(22, 20) 666.7787[.000]	DW-statistic: 2.2178
σ of Regression: 0.022857	Breusch-Godfrey test: $\chi^2(1)$= 0.64724 [.421]
Ramsey's RESET test: $\chi^2(1)$= 3.3113[.069]	Jarque-Bera test: $\chi^2(2)$= 0.73514[.692]
Engle's ARCH LM test: $\chi^2(1)$= .085215[.770]	

Apart from the high significance levels of variables and the existence of a long-run relationship, our model is statistically well behaved. We applied a number of diagnostic tests to model 3, such as Breusch-Godfrey or Lagrange Multiplier test of Residual Serial Correlation and found no evidence of autocorrelation in the disturbance term. The evidence of no auto-correlation was further confirmed by the value of diagnostic test, D.W. Statistic 2.2178. The Engle's ARCH LM test of Heteroscedasticity suggests that the errors are homoscedastic and independent of the regressors. The model passes the Jarque-Bera test of Normality suggesting that the errors are normally distributed. However, the Ramsey's RESET test of Functional Form indicates that the model is not correctly specified but functional form is not a big issue in ARDL modeling Approach. While the adjusted R^2 of the model is high implying an excellent fit of the model- about 99% of the variation in the fish production is explained by the regressors. In addition, the F-statistic is significant at less than 1% level expressing that the model has an overall good fit.

For stability of model 3 (parameter stability), we test the model by cumulative sum of residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) tests. It was found that model is stable (short run and long run coefficients in the ARDL/ECM are stable) as neither CUSUM nor CUSUMSQ tests exceed the lower and upper bounds of 5% level of significance. Therefore the null hypothesis of all coefficients in the given regression model are stable cannot be rejected.

THE GRAPH OF CUSUM & CUSUMSQ FOR MODEL 1 IS SHOWN IN FIG. 8.2.3



9. CONCLUSIONS, SCOPE FOR FURTHER RESEARCH & POLICY IMPLICATIONS

This study was primarily conducted to empirically investigate the impact & possibility of existence of long-run relationship between fish production & environmental factors in temperate valley of Kashmir. In this study error correction and cointegration techniques based on newly developed ARDL modeling approach, were applied to construct a fish production model for Kashmir Valley covering period 1965-2010. The findings support the existence of long-run equilibrium between fish production and economic & environmental determinants both at aggregate level as well as at individual specie level. It was found that in the long run, actual number of fishers and number of fishing boats acquire highly significant relationship with fish production in case of Kashmir Valley. While in case of Shizothorax fish production, carp specie, mean annual atmospheric temperature turned out to be significant. And in case of carp & Shizothorax species, actual number of fishers, number of fishing boats, mean annual rainfall and mean annual atmospheric temperature were found significant. The findings on the short-run relationships show that fish production (with two lags), actual number of fishers, number of fishing boats and mean annual water level of the wetland have significant impact on the total fish production. While in case of Shizothorax fish specie, carp specie (both current period and lag period), actual number of fishers, and mean annual atmospheric temperature were found significant. The short-run determinants found significant in case of carp fish specie are shizothorax specie (both current period and 2 period lags), number of fishing boats (with 2 lags), lagged mean annual rainfall, mean annual water level of the wetland (with 2 lags) and mean annual air temperature (both current period and 2 period lags). In doing so, this paper has made a significant contribution in explaining impact of economic & environmental determinants on wetland fish production. The study therefore supports recent calls recommending that environmental factors have certain impacts on wetlands and wetland fisheries. This research contributes to the field of fisheries economics in two important ways. First, it explores the impact of environmental variables (besides economic variables like fishing effort) if any, on the wetland fish production. Second, it explores the impact of environmental variables (including exotic species) on certain species of fish. By and large, our analysis reveals that the environmental factors have an impact (negative/positive) on fish production in temperate zones like Kashmir valley both in the short-run and long-run. The key findings of the study support the hypothesis regarding the role of environment in natural aquatic production functions and shows that environmental variables are equally important to fish production in temperate zones like Kashmir Valley. The policy implication which can be drawn from the study is that if fisheries sector is to be made sustainable then impact of environmental determinants must be taken into policy making. Indeed an area for future research would be to estimate the relationship or nexus between inland fish production and economic & environmental determinants using data from different temperate & tropical wetlands.

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