IMPACTS OF CLIMATE CHANGE ON THE PRODUCTION OF COTTON IN SIND: A TIME SERIES ANALYSIS

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ABSTRACT

A climate change phenomenon has multidimensional impacts on environment and human wellbeing. In an agrarian economy its impacts are more long lasting and deep rooted. Since the advent of the world, climate has passed through various changes over the time. The process of industrialization of the world is responsible for climate change. England's industrial revolution and industrial development in U.S.A on gigantic scale were responsible for bringing out climate problems which are now being encountered by the less developed economies. The effects are more evident in agrarian based economies like Pakistan. The main object of this study is to quantify the impacts of climate in Pakistan to have better understanding of climate issues.

We took data of cotton production in Sind Pakistan from 2001 to 2012. We applied auto regressive distributed lag model in E-views. We analyzed the impact of rainfall and temperature on cotton production. The result comes out that increase in temperature increase the cotton production and its significance. And temperature increase in previous year also affects the cotton production and significance. But increased in temperature of year before previous year increases the output but it is insignificant. Same as increase in rainfall of current year decreases the output and is insignificant. But increase in previous year rainfall increases the output and significance. Increase in rainfall year before previous year decreases the output and is insignificant. And increase in rainfall and temperature overall decreases the output of production of cotton. The study has confirmed that change in climate has significant impact on cotton production.

Keywords: Climate change impacts, rain, temperature, cotton production.

INTRODUCTION

Pakistan has less resources and modern technology and thus has low ability to cope with the negative impacts of climate

change. In Pakistan climate change causes losing at least 5 % GDP per year.

According to a World Bank Report (2006), the country loses approximately $4.5 billion annually from environmental disasters. The risks and challenges of climate change for Pakistan are Increased health risks, Decrease food production, Food ,water and energy security, Natural resources management.(altering the growing periods of crops),Water scarcity, Reduced agricultural productivity, Poverty eradication, Food safety and security (drought of 1998-2001), Export industry of fisheries get effected, Loss of property due to flooding of home of people living near the remote coastal areas, Loss of infrastructure (due to heavy rain of 2010 and 2009 resulting the flood of 2010, cyclones, earth quake in 2005, Energy consumption: higher temperature will increase the electricity demand of country),Changing weather patterns, such as increased flooding, droughts, changes in freshwater supply and an increase in extreme weather events, Loss of natural reservation: Himalayan Glaciers melting rapidly increase the sea level, Heavy snowfall and land sliding (Hunza valley land sliding on January 4, 2010 buries the village of Attabad and blocked the Hunza River),Increased air pollution in Pakistani cities such as Karachi and Lahore, Biodiversity loss: Hundreds of rare plants and animals in danger of extinction, Increased exposure to extreme weather events, Natural disasters.

H_O = Rain and temperature does not affect the production of cotton.

H_1 = Rain and temperature affect the production of cotton.

Objective of the study is to analysis of Pakistan's vulnerability to climate change and its different aspects. To investigate dimensions of socio economic vulnerability to climate change. The global warming negatively effects the production of different sectors of Pakistan. To what extent climate change significantly affects the economic conditions of Pakistan specially the production of cotton in Sind.

Determine the factors that generate or facilitates the climatic change. To what extent climate is beneficial in increasing the economic growth of Pakistan. Determining the adaptation policy to assess the impacts climate change will have.

The study provides a clear understanding about how a climate change can affect the economic growth of the country and it provides evidence of climate change in different sectors of Pakistan, which provide base for the formulation of policies to assess the impact of climatic change on these sectors and how these policies can be useful in accessing the economic cost of the country.

EMPIRICAL EVIDENCE

Cullen & Idean (2012) identify the Climate change, rainfall, and social conflict in Africa: The Rainfall affects the whole activities of the human regarding with the any field. In this paper discuss the conflict in Africa due to the change in climate, rainfall and cultural. In this article found the weather deviations from normal rainfall pattern affect the tendency for individuals and groups to connect in disturbing activities such as demonstration riots, strikes, mutual conflict, and anti-government violence. Large deviations in rainfall – particularly dry and wet years – gives the positive relationship with all types of political divergence. By looking at a broader scale of social conflict, rather than restrictive the analysis to civil war, we demonstrate a strong relationship among environmental shock and fighting.

Koubi *et.al.,* (2012) studied climate in relation to conflict and economic growth. The paper highlighted the ancillary impact of the climatic environments on conflict and unpredictability in the climate. It was an experimental study and the paper failed to prove that economic growth is pretentious to climatic variability. The study, nonetheless, found a weak relationship between worsening economic condition and civilian conflict. The research was completed in two stages. Firstly, the effect of climatic change on civilian conflict and economic growth were studied. Secondly constant economic change was studied in relation to economic activity

Halvard *et.al.,* 2012). The research paper is basically regarding the climatic conditions of Sahel and investigations about the diverse climatic changes were made by mainly focusing on the inland delta of Niger River of Mali and are considered as the heart of Sahel. In this research two critical approaches were used. The first approach was based on the study as well as the assortment of

court data about land-use-conflicts. Sample period is of 1992-2009 is taken. The result was evaluated by comparing the conflict data with the statistics of the simultaneous climatic conditions and it was found that inconsistency of climate is the basic reason behind the conflicts. The second approach which was used was based on selecting one land-use conflict of the region and then carrying out a qualitative study of it. Result indicates that factors which were not directly related to environmental conditions and the outcome elaborated that the dominate reason behind the violent conflicts is scarcity of resources.

Khan (2011) identifies the Changing Climatic Patterns and Their Impacts with Special Focus on Pakistan. In this paper we study that human activities including burning of fossil fuels, clearing and burning of forested land and converting organic carbon into Co_2 and social, economic and environmental impacts of climate change in Pakistan. Environmental effects of climate change includes decrease in water supply affecting food production, Export industries, fisheries, inundation of coastal areas and flooding of homes of millions of people living in low lying areas. The recession of glaciers due to rise in temperature may cause the reduction in flows of Indus river which may highly effect Pakistan's agriculture, hydroelectricity and water supply. Climate change has negative impact on agricultural productivity because it may cause changes in growing period of crops, changing soil characteristics; increase the risk of pests and diseases. The study recommends that Pakistan must highlight the related issues and also promote cross-sector integration of climate change issues in national policies and plans.

Hallegatte & Henriet (2011).This paper presents the model projecting impacts of climate to assess the certainty of urban economies in future events. Changing in climate is an obstacle in economic development of urban communities, which can be controlled by the government through imposing various policies. There is cost and benefit of adapting environmental policies .costs is short term but benefits will be reaped in future. In this research paper author recognize cost, benefit, limitations and barriers of fully adapting mitigation policies, effects of partial adoption of those policies and effects of no adaption of policies. Change in climate is independent variable and market and non-market

impacts are dependent variable. This paper suggested that extreme weather because health problems which leads to decrease in worker's productivity, rise in sea level cause asset loses, landscape losses, what are migration's impacts on country's economic performance.

Pindyck (2011) study about the climate could affect economy activity through both theoretic and empirical evidence economy. The destruction of economy system from erosion, flood and drought the extinction of danger species and death result from extreme weather cause devastate to economic growth and the resource required to overcome effect of warming would decrease in investment, physical infrastructure research and development, human capital. Theoretic we can link with macroeconomics and microeconomics measurement. Macroeconomics sides affect the level of output such as agriculture and economy able to grow. Microeconomics links the labor productivity such as physical and cognitive health. Increase in temperature cause political instability which may slow down factor accumulation and productivity growth. The overview is that the direct effect on economic growth and indirect effect on variables such as morbidity and mortality.

Shakoor *et.al.,* (2011) Impact of Climate Change on Agriculture: Empirical Evidence from Arid Region This study shows the economic impact of climate change on agricultural sector of arid regions in Pakistan. It also shows that how different climatic variables have affected the productivity and profitability of agricultural sector. Agriculture has been considered to be the backbone of a country especially for countries like Pakistan. Over the past few years climatic change has become a serious issue for Pakistan and as a result it faces tremendous social and economic vulnerability. Pakistan stands 28th amongst the countries that are highly affected by the change in climate. Climate change is resulting into high temperatures and almost no rainfall.

Uzma *et.al.,* (2011) identify the Economic Impact of Climate Change on Agricultural Sector of Punjab. The aim of this study was to know about the Impact of Climate Change in the development of Agricultural sectors both in Regional and Country level. Agricultural sector plays a major role in GDP of Pakistan. They conducted their survey of the total land area of Punjab province. In this study dependent variable is land Price and

Independent Include Climate (Kharif crops and Rabi crops) and non-climate variables (district wise yearly population density i.e., persons per square Kilometer and per capita income per year). The data of population density and area under cultivation and per capita income were also taken .The result showed that there is a significant relationship of rainfall with the land prices both in Kharif and Rabi season and also indicated that with decrease in Rabi precipitation together with an increase in maximum Rabi temperature will tend to increase the land price in this season.

Absar (2010) identify The Impact of Climate the Change on the Glaciers, Water Resources and Livelihood of Pakistan. that climate change often results in floods due to melting of the glaciers and so just focusing on irregular supply of water system and creating the diversions by the upstream users are not enough so the results were very devastating for the economy of the country instead main focus should be on the balance of supply of water at the time when it is actually needed for the purpose of irrigation and when floods are generated .paper suggest that dams should be there to preserve the water coming from the excessive floods and effective water policies should be there to control the demand of water and enforcing overall conservation of water to reach for the fruitful result.

Stern (2007) investigates "What is Economics of Climate Change" This study is regarding the most serious issue that is how human activities are resulting into causing climate changes especially global warming. The research paper basically elaborates that their do remain uncertainties regarding the nature as well as scale of the long-term impacts but through scientific evidence there are still indicators that our climate changes are taking us into dangerous territory. It is found that the resulting temperatures are expected to be higher than ever been in the past 5 million years. It was concluded that both rich countries and the involvement of developing countries will be must in order to significantly reduce emissions.

Andrew *et.al.,* (2007). This study mainly focuses on assessing the vulnerability on the food crop system in Africa due to climatic change .This study revolves around three aspects i.e. sensitivity of crop due to variability in climate, adaption capacity of farmers and what measures are taken by institutions regarding

climate change. Uncertainty basically originates from the inability to calculate the crop productivity impact across Africa. The results calculated predict crop yield significantly decreases due to climate change. Cereals may have higher yield but this yield is not sufficient enough to compensate the losses in wheat, maize, rice and millets. Their techniques include planting a variety of those crops which suits a variety of conditions, using that land which can handle more climate variations naturally, accumulate as much as they can, and save water as much as they can. These techniques may help crops but farmers and people of Africa face much more than this. Obstacles like diseases, political and instability, conflicts and unfair international trade system. Study recommends that government here needs to take effective measures against climate change. Government support will result in increased security for farming and gives strength to farmers.

Hassan & Gbetibouo (2005) identify the impact of climate change on South Africa's field crops and investigates potential future impacts of changes in the climate. A vast change has taken place in agricultural sector globally. Ricardian method is used .Data used in this research is cross-sectional There were seven samples of soil which are (maize, wheat, sorghum, sugarcane, groundnut, sunflower and soybean. It has been studied and calculated in different tables about the aspects. In one of the model Parameters were estimated of the Ricardian field crops model to check the effect of rain and temperature which had 300 numbers of observation and level of significance at 5% and 1%. Other than that in this paper Estimation of elasticity to climate factors were checked, Impacts of changing only temperature or rainfall on field crops' net revenue in percentage and also Sensitivity of the impacts of climate change on net revenue to climate scenarios in percentage. We concluded that temp effect was positive but rain has negative effect on it.

Mendelsohn (2005) studied the climate change and its impact on the Southeast Asian agricultural sector. The paper found out that the existing temperature of a location plays an important role. Regions with an existing cool temperature will benefit from an increase in temperature, locations with moderate existing temperature benefit modestly; however, locations that already have a hot weather will be damaged with any increase in temperature.

The study revealed that four factors influence agriculture; First, response, size of the sector, existing temperature and precipitation and the climate scenario. A country with a large agricultural sector is impacted greatly with changes in the climate. The study concluded that locations with mild scenarios are at an advantage as compared to locations with a hot temperature.

Olesen & Bindi (2002) investigate the Consequences of climate change for European agricultural productivity, land use and policy". Climate change in northern areas of Europe may produce positive effects on agriculture through introduction of new crop species and varieties, higher crop production and expansion of suitable areas for crop cultivation. However, disadvantages may be an increase in the need for plant protection, the risk of nutrient leaching and the turnover of soil organic matter. On the other hand, the disadvantages will predominate in the southern areas. The possible increase in water shortage and extreme weather events may cause lower harvestable yields, higher yield variability and a reduction in suitable areas for traditional crops.

Jones (2001) investigates "An Environmental Risk Assessment/Management Framework for Climate Change Impact Assessments" as under the Australian and New Zealand risk management standard 1999 in mentioning the terms risk analysis where the level of risk is assessed and risk treatment where the level of risk is decreased through devised intervention. The risk handling phase according to him may contain two complimentary actions: adaptation to the anticipated variations in climatic change or the climatic change mitigation by the decrease of greenhouse gas emissions. Both of reactions are considered being able to decrease the risk related to critical threshold being exceeded if properly seen and implemented.

Yates & Strzelecki (1998) provided an evaluation of integrated climate change influences on the unindustrialized economy of Egypt. The paper studied water availability and yield decline and it showed that how farmers are being adversely impacted by changing climate. The paper provides support to the argument that smaller food producing countries have greater chances of being affected by changing climate, and also with changing biophysical system in the national economy and the regional economy. The results manifested that more sectors need to

be studied since study of a single area cannot provide ample knowledge of the effects of climate change. Climate change affects many socio-economic sectors in agricultural economies such as productivity, food entitlement, food export and trade deficit.

MODEL AND DATA ANALYSIS

If t-value comes out to be around 2 or more than 2 then the estimated co-efficient is statistically significant and if not than the estimated co-efficient is not significant statistically.

TABLE: 1
DEP. VARIABLE: PROD
METHOD: LEAST SQUARES
OBSERVATIONS INCLUDED: 12

Variable	Coefficient	Std. Error	t-Statistic
C	-26396.67	31975.00	-0.825541
Temp	1109.504	987.1988	1.123891
Rain	-3.093166	2.378924	-1.300238

TABLE: 2
DEP. VARIABLE: PROD
METHOD: LEAST SQUARES
OBSERVATIONS INCLUDED: 10 AFTER ADJUSTMENT

Variable	Coefficient	Std. Error	t-Statistic
C	-210913.0	58153.11	-3.626857
Temp	2725.565	786.1376	3.467033
Rain	-6.524566	1.848269	-3.530095
Temp (-1)	1095.096	842.9952	1.299054
Rain (-1)	2.633328	2.122412	1.240724
Temp (-2)	2984.138	984.6519	3.145661
Rain (-2)	-1.245544	1.622473	-0.767682
Prod (-1)	-0.090007	0.255514	-0.352257

MODEL AND INTERPRETATIONS

The model we have used to conduct our result is Auto Regressive Distributed Lag Type Model:

$$\mathbf{Prod} = \alpha + \beta_1 \mathbf{Temp}_t + \beta_2 \mathbf{Temp}_{t-1} + \beta_3 \mathbf{Temp}_{t-2} + \beta_4 \mathbf{Rain}_t + \beta_5 \mathbf{Rain}_{t-1} + \beta_6 \mathbf{Rain}_{t-2} + \beta_7 \mathbf{Prod}_{t-1} + \mathbf{e}$$

TABLE: 3

	ESTIMATED VALUES	**T- VALUES**
β1	2725.565	3.467033
β2	1095.096	-3.530095
β3	2984.138	1.299054
β4	-6.524566	1.240724
β5	2.633328	3.145661
β6	-1.245544	-0.767682
β7	-0.090007	-0.352257

The study has taken into account the two independent variables and one dependent variable from Sind Pakistan. The model of auto regressive lag type has captured the information about the production of cotton being affect by the rain and temperature. Feasible generalized least squares method has been applied to run the regression panel test. The following results were obtained after applying the lag is:

β1= Increase in average level of temperature increases output of cotton and its statistically significant.

β2= Increase in the average level of temperature of previous year also resulted in increase in output and it is also statistically significant.

β3= Increase in the average level of temperature of the year before previous year resulted in increasing output of cotton but it is not statistically significant.

β4= Increase in average level of rainfall in current years decrease output statistically not significant.

β5= However increase in the rainfall in the previous year increase the output of cotton is also statistically significant.

β6= Increase in rainfall before previous year decreases output but it is insignificant.

β7= Increase in rainfall and temperature of the previous year decreases the overall production of cotton and it is insignificant.

RECOMMENDATION

The result shows that the rain during the year decrease the production of the cotton, so there should be a foolproof drainage

system installed in the cotton fields to drain out the excess water which is left behind by the rains. While the extended rains cause floods in the region which destroys the cotton farms. The government should intervene and build flood routes and high flow drainage passages to keep the water out of the cotton fields during the floods. As the flood problem is solved the problem of soil erosion will automatically be solved as the floods carry the enrich soil for cultivation with it and leave salts on the surface of the land. Land should be made available on such areas where the temperature are constant and high as cotton production takes place in warm temperature rather than lower temperatures. Thus result in labor productivity.

Results indicated that the rain from l a year past helps increasing the production of cotton of the current year, so the supply of water is also very crucial and water should be stored via creating pounds locally or build dams for storage of large amount of water to be used in farming and other purposes. There should be a proper canal system for the timely supply of water to the cotton plants to ensure healthy growth for higher yields of cotton. Government should make the foreign seeds available to the local market which are biologically strong and have the strength to endure the extreme climates variations.

CONCLUSION

We have used Auto Regressive Distributive Lag Type Model in which rain and temperature are treated as independent variables while cotton production is treated as a dependent variable for finding out the significant results we have applied lag two times to make our result significant. Beta with a (-ve) sign here is not been considered but we have consider it because it is non-stationary. So we are taking the result which is showing us the statistically significant affect on cotton production by rain and temperature. Hence, it is proved that the cotton production is dependent up on rain and temperature. So we reject H_o and conclude that the production of cotton is affected by rain and temperature.

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