

Impact of global climate change on economy of Pakistan: how to ensure sustainable food and energy production

Abstract

In this paper we present the changing global environment and its potential impacts on sustainable food and energy production at global level, particularly in Pakistan. The food and energy related-economic sector has been subjected to negative consequences due to recent extreme changes in weather conditions, particularly in developing countries. Besides continuous modifications in weather, population is also increasing by time, therefore it is necessary to take special steps and start effective initiatives to cope with the challenges of food and energy security to fight hunger and for economic stability of country. This paper presents a framework-plan and recommendations for implementation needed to mitigate the potential threats due to global climate change sustainable food and energy production under climate change in the country.

Keywords: global climate change, Pakistan, food security, energy security

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Introduction

Changing climate is a potential driver of change in sustainable food and energy production. It directly and indirectly affects food and energy security by threatening food production and end use quality. Moreover, there is a gradual decrease or loss of natural resources of food and energy as a result of natural disasters, along with climate change. In recent years, Pakistan has faced overwhelming losses due to only floods that have negatively impacted infrastructure and the agriculture sector in Pakistan. In 2010 alone, those losses exceeded US\$ 9.6 billion. Since 2010, five consecutive floods resulted in more than US\$25 billion of economic loss in damages to different sectors like agriculture, irrigation, public infrastructure, health and educational facilities, etc. Industries associated with cotton, which is the main cash crop in the country, are among the most affected. In addition to severe weather modifications, increasing population and urbanization are also contributing to security issues, including, but not limited to issues of adequate food, production supply, and poverty control. According to the United Nations forecast, world's population is expected to increase from 7.2 billion today to 8.1 billion in 2025. Likewise, Pakistan is also facing the same situation of increasing population and climate change impacts on economy. Severe increase in temperature and heat waves has also negative impacts on food production as well as energy sustainability. Energy (in terms of electricity) consumption has grown up than the production potential of the country as a consequence of increasing warm weather. Ultimately prices gone up when there is more consumption than production. Therefore, all these aspects of climate change are interrelated with socio-economic issues. There is a need to develop long term policies on regional and national levels for maintainable economic growth.

Scope and significance of research

The research that we have conducted and presented in this paper

is an assessment of the current situation of global climate change and its impacts on Pakistan. It will review the direct and indirect effects of changing climate on food and energy security and sustainability of natural resources. This study deals with the climatic impacts on socio-economic factors, while considering the importance of agriculture and energy in the economy and its contribution in country's progress. It analyzes the efficient use of natural resources, loss of natural resources, and increasing demands of water and energy with respect to climate changes. In addition to risk assessment due to global climate change and potential threats to Pakistan, this paper provides a framework-plan for implementation needed in a scenario for sustainable food and energy production under climate change in the country.

Objectives

The main objective of this study is to assist in describing a framework that could be implemented to determine the socio-economic impacts of continuous severe changes in weather on food, water and energy.

In our study, we shall present a scenario to deal with the following main challenges;

1. Reducing the negative impacts of climate change food and energy
2. Agricultural production sustainability and rural development
3. Promoting modern technology and productivity growth
4. Strengthening the farming sector for trade markets and inputs
5. Efficient use and conservation of natural resources
6. Developing long-term shared capacity for strategic planning

Outcome

This study will be helpful in developing a scenario for adequate

food production and supply, efficient water conservation and its use, and sustainable energy production under changing climate; ultimately it will have a positive impact with respect to socio-economic development.

Review of literature

Global climate change

According to Wheeler,¹ climate change can be the result of natural causes, human activities, and the emission of greenhouse gases such as carbon dioxide and methane and changes in land use. Climate change brings modifications in duration and intensity of weather conditions by creating warmer temperatures, changes to rainfall pattern, and increased frequency and severity. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change describes a clear human influence on climate behavior. This report states that: "Climate change will amplify existing risks and create new risks for natural and humans".² Risks associated with climate change can be due to harsh weather conditions such as severe heat waves, excessive precipitation, and continuous flooding. The intensity of heat waves has increased in large parts of Europe, Asia, and Australia. Similarly, the occurrence of heavy precipitation events has also increased in land.

Economic related impact of changing climate in Pakistan

Food: Food security is primarily related to crop production and food accessibility; both of these elements are directly affected by climate change. Thus, climate change is a main factor determining global, national, and regional food security. According to DailyTimes Report, (April 16 2015), TheClimate Change Federal Minister, Senator, Mushahid Ullah Khan recalled and warned that natural calamities would show increased frequency in the country. The one single event of devastating 2010 flooding eroded away 6 percent of our GDP. The World Wide Fund for Nature-Pakistan (WWF-Pakistan), in collaboration with the London School of Economics-Political Sciences and Lahore University of Management Sciences presented a report and highlighted the issue of climate change in Pakistan and its impact on agriculture and food security. According to this report, changing climate will directly affect agricultural productivity. By 2040, an increase in average temperature of 0.5 degree Celsius is expected nationwide, with 8-10 percent loss in terms of all crops corresponding to Pakistani Rupees 30,000 per acre.

The 2014 German Watch Index, a German-based prestigious think-tank on climate change, reported Pakistan as among top ten most vulnerable countries in the world. Only during 2010, the flood resulted in 6 percent loss of country's GDP. A joint study by Global Change Impact Studies Centre (GCISC) and Pakistan Meteorological Department (PMD) about future scenarios in context of climate change in Pakistan revealed that there are significant changes in temperature and increasing trend in both minimum and maximum extremes over the region. Therefore, in the scenario of high vulnerability to severe impacts of climate change related to food security and sustainable energy production, a policy document as a framework has highlighted the necessary adaptations for various sectors such as agriculture, water, energy, and livestock. (GCISC & PMD and joint report on climate change 2007).

Energy; Climate change has direct consequences on energy with respect to its use and production. The main effects of changing climate

are an increase in energy consumption in residential, commercial, and industry sectors for different purposes such as for space cooling in response to increased temperature and industrial process cooling (in thermal power plants and steel mills), refrigeration, pumping water for municipal and agricultural irrigation. Energy delivery and fuel types such as electricity use for air conditioning and use of natural gas for heating are also affected. The idea of energy security relies on following three stages defined by Martin et al.³

- a. Availability and adequate supply of energy to meet increasing demand
- b. Accessible energy resources
- c. Potential of guaranteed fuel supply without any disturbance by external factors.

Wilbanks et al.,⁴ described that the most remarkable potential impacts of climate change are as follows:

- i. Increase in energy consumption for cooling purposes in residential, commercial, and industrial areas.
- ii. High electricity consumption for residential and commercial refrigeration
- iii. Increase in energy supply to such resources that are climate responsive, for example pumping water for irrigated agriculture and municipal uses
- iv. Changes in the form of energy use and its type such as use of electricity for air conditioning and natural gas usage for heating purpose.
- v. Changes in energy consumption in that climate sensitive sectors that play role in the economy, such as transportation, construction and agriculture.

According to National Economic & Environmental Development Study Report,⁵ during 2008-2009, Pakistan's net energy consumption was 37.3million tonnes. This energy consumption was met from different sources including gas (43.4%), oil (29%), electricity (15.3%), coal (10.4%), and LPG (1.5%). All of these energy sources collectively account for 51% of the national greenhouse gas emission. In contrast to last ten years, use of petroleum has increased by 0.5% per annum, gas by 6.8%, electricity by 5%, and coal by 12.5% per annum. Whereas, in the last five years there has been an increase in gas consumption by 9%, an increase in coal consumption of 1.5%, and a reduction in oil consumption by 9.5%.

Methodology

The present study is primarily based on literature studies; figures and facts have been referred from secondary data. Typical sources of study are reports of international institutes and organizations, publications by government sectors and non-government platforms, research articles, media, and internet resources. Further, data from assessment reports and official documents issued by different state department working on climate change and its relation with socio-economic aspects in the country has also been included in this paper. The documents and reports were obtained from; German Watch Index, the Food and Agriculture Organization of the United Nations, Government of Environment and Climate Change; Ministry of National Food Security & Research, Finance state department, Food, Agriculture & Livestock Division, Pakistan Flood Commission, Pakistan Agriculture

Research Council and Pakistan Planning Commission. In addition, the reports, documents, and policy briefs obtained from different NGOs working in Pakistan and UN organizations were also consulted. This study consists of different sections to analyze the impacts of climate change in recent years and the status of Pakistan with respect to its consequences on food, energy, and natural resources. The first section of this study is about the background information of the problem being studied. Second, methodology of current research and sources of literature review are mentioned. Third, the pattern of climate change in the world is described and countries that are most affected with this change are listed on the basis of different variables (especially food insecurity and GDP). It provides the analysis of economic losses due to climate change globally and particularly in Pakistan. The fourth section provides overviews of potential threats to agriculture, energy, and water sector due to extreme temperature and floods in relation to Pakistan. The last part of this study is focused on conclusions and recommendations, based on potential impacts of climatic change and strategies needed to develop as a future scenario, in light of available resources.

Climate change is increasing vulnerability all over the world and people are facing severe effects of variable environments at the global level. Extreme weather conditions have led to big losses in terms of increased death rate and economy damages. Changes in climate can shift the seasonal crop pattern; thus, resulting in delayed planting and harvesting. Elevated temperature and shortages of adequate water may affect the productivity of crops and livestock. The food security threats related to production pattern and performance impacts will likely cause risks for the livelihood of small scale farmer and producers in developing countries, who are less able to cope with these harsh climatic changes; thus, their safety and welfare is compromised.

Socio-economic losses to most recently climate change-affected countries

According to global climate change risks index,⁶ Philippines, Cambodia, and India were the most affected countries, while Pakistan was ranked 9th in 2013 (Table 1).

Table 1 The climate risk index for 2013: The 10 most affected countries

Ranking 2013 (2012)	Country	CRI score	Death toll	Deaths per 100,000 inhabitants	Absolute losses (in million US\$ PPP)	Losses per unit GDP in %	Human development index10
1	Philippines	2.17	6479	6.65	24538.56	3.82	117
2	Cambodia	6.67	184	1.22	1495.52	3.24	136
3	India	12.67	7437	0.6	15147.02	0.22	135
4	Mexico	15	224	0.19	10589.7	0.51	71
5	St. Vincent and the Grenadines	15.33	9	8.18	96.58	8.33	91
6	Pakistan	15.5	301	0.16	5419.77	0.65	146
7	Lao PDR	17.67	23	0.34	263.51	0.83	139
8	Vietnam	17.83	152	0.17	2397.04	0.5	121
9	Argentina	20.33	122	0.29	2010	0.22	49
10	Mozambique	21.67	119	0.46	88.21	0.33	178

Losses from natural disasters

Natural disasters are creating alarming situations globally by disturbing ecosystem, in addition to limiting water supply and land use for agricultural purposes. The consequences of natural disasters are; reduced soil nutrients, soil erosion, desertification, and depletion of natural water resources. Biodiversity is also getting affected by climate change conditions and human behavior like urbanization, deforestation, and pollution etc. Gene pool diversity, which is a key tool for improving agricultural products, is decreasing in natural ecosystem due to modernization in agriculture, natural disasters, changes in climate and human habits, and increasing population size. Pakistan has been facing continuous threats and damages because of natural disasters like earthquakes, intense heat waves, and flooding in recent years. Since 2010 to onward, the country has had to deal with the consequences of severe flooding. Even as recently as 2015, flood warnings have been issued in Punjab. These natural devastating conditions are likely to cause big economic loss by destroying the infrastructure and imposing severe impacts on food security. During

past few years, Pakistan has faced overwhelming losses due to only floods. In 2010 alone, those losses exceeded US\$ 9.6 billion. Since 2010, five consecutive floods resulted in more than US\$25 billion of economic loss in damages to different sectors like agriculture, irrigation, public infrastructure, health and educational facilities, etc. (Government of Pakistan Climate Change Division Pakistan, November 2013).

Future climate change in Pakistan and expected consequences

According to Global Facility for Disaster Reduction and Recovery organization (GFDRR) temperature will be increased by 1.4 to 3.7°C in the south and coastal regions of Pakistan by 2060s. Rainfall forecasts vary from region to region and season to season. Heavy rain falls may increase in proportion, resulting in severe damages to infrastructure and agriculture sector particularly.

So, it can be concluded that Pakistan can suffer high extreme weather changes. As a consequence of these uncertain weather

conditions, crop production will be affected directly. There would be a serious reduction in adequate food production and change in energy production and demand. A Brochure on climate change by Pakistan Institute of Development Economics describes that due to increase in temperature growing season for major cereal crops will be declined in all agricultural zones of Pakistan, following 6-11 % reduction in wheat yield and 15-18% reduction in yield of basmati rice by year 2080. While livestock production could reduce by 20-30% due to increase in temperature pushing prices high.

Sustainable Food and Energy Production Policy; To Feed and Fuel the Future

It is being considered that the rate of burden on natural resources-land, water, biodiversity, energy will be somewhat moderated in the next 50 years as compared to past 50 years. However, there will be contradicting situation in case of food and biofuel due to environmental degradation and increasing population. Just satisfactory expected food and feed demand will require 70 percent increase in global food production [7]. Due to continuous climatic change and its impacts on food production and accessibility, developing countries are subjected to negative impacts where food insecurity already exists. To meet the challenges of food security in response to projecting demand, there is need of an action plan to ensure the availability of adequate food to people in the country. In developing countries, the agriculture sector must be given more priority in the field of research, development, and extension services.

Monitoring of climate system

For achieving the goal of sustainable food production and to feed the increasing population in future, collaborative work is necessary between Government, Research institutes, and international organizations. The most important component of this scenario is to create effective links with global markets and the international trade system to have access to stable food and energy supply through a framework. Long term policy and framework for sustainable food production mainly require;

- i. More investment in agriculture sector to enhance production potential,
- ii. Introduction and use of modern technology,
- iii. Support to farmers and effective extension services, and
- iv. Linking global trade markets to national sectors.

The framework should include essential factors and variables that will be considered for adjustment of food and energy system in climate change. These basic factors are Greenhouse Gases concentration in the atmosphere, elevating average, minimum and maximum temperature, changes in precipitation, increasing drought conditions, modifications in rain pattern, continuous and numerous flooding and storms, and significant changes in duration of growing seasons (Figure 1). The GCOS and its affiliated institutions give support to different organizations and Programs, such as the United Nations, Framework Convention on Climate change, the World Climate Research Program and the Intergovernmental Panel on Climate Change.

- i. The report based on the climatic variables gives valuable information for;

- ii. Assessing and monitoring the condition of global climate system and its flexibility
- iii. Supporting the attributions of climate change and its predictions
- iv. Spreading the information of global climate change at regional and local level
- v. Enabling characterization of severe events having vital impacts and necessary adaptations in response to these impacts

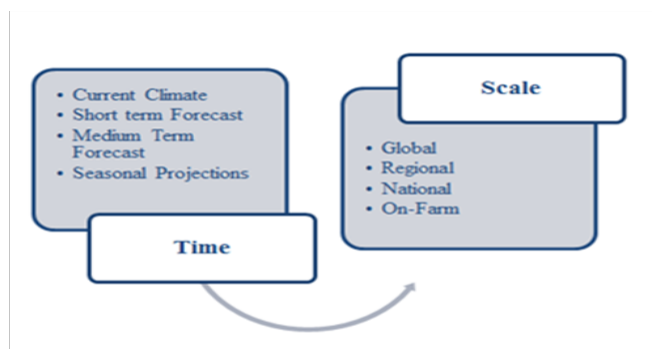


Figure 1 Scheme of assessing climate change impacts for different time periods in different levels.

Model to monitor climate at national and regional level in Pakistan

Development of climate models and collaboration of different international and national institutes and organizational bodies should be made possible for the analysis of climate change associated risks, particularly to food and energy.

- a. The concerned climate change assessment model should have main two characteristics: Ability to develop Institutional capacity of Global Change Impact Studies Centre (GCISC) and other relevant organizations to develop future climate modifications at national and at farmers and local planners scale according to regional data.
- b. Use of this information for decision and policy making step in agriculture and energy sector.

Following are the few examples of implementing institutions:

- i. FAO- Food and Agriculture Organization of the United Nations
- ii. IFPRI- International Food Policy Research Institute
- iii. International and National Energy and Organizations Institutes
- iv. GCOS- Global Climate Observing System
- v. International and National Agriculture and Engineering Universities and Research Institutes
- vi. Pakistan Meteorological department
- vii. Media (Electronic- TV Radio, Print)
- viii. Extension Services Management Academy
- ix. Bureau of Statistics and other data collection agencies
- x. Policy making Government institutes for development

Food security framework and recommendations

There is a considerable number of developing countries that have achieved the goal of food security successfully. There is no doubt that a successful food security policy has three basic characteristics including political stability, good governance and strong economic growth. Ensuring food sustainability under climate change will play important role in social welfare and environmental security by improving economic and ecosystem stability, respectively (Figure 2).

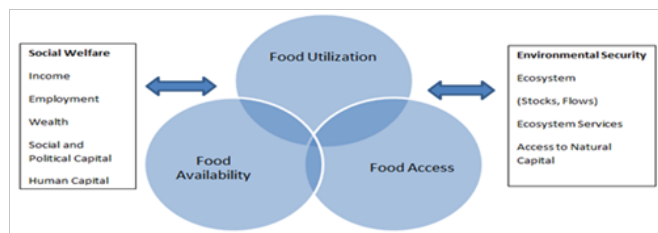


Figure 2 Food security outcome.

Recommendations

Ensuring food security through mitigation of climate change:

Assessments of climate change risks, susceptibility, and improving and implementing early warning systems, weather forecast system and food security plan in response to environmental challenges is necessary especially in a coordinated manner with national and international organizations.

Integration of climate change aspects into food policies: Climate change concerns should be integrated in food security policies and programs to increase resilience of vulnerable groups and food systems to climate change, emphasizing adaptation to climate change as a major concern and objective for all farmers and food producers, especially small-scale producers.

Mobilization of political will: At present, many countries have achieved goal of sustainable food production and fight with hunger by giving priority to this issue. However there are still other countries that either have not been successful through efforts or did not make framework and action plan. Although some under developed and low income countries are facing specific resources constraints but still they need to give priority make action plans. Therefore, political will should be mobilized for food security.

Building institutions: Effective institutions are signs of good governance. There should be such institutions that ensure the contribution of agriculture and rural areas in sustainable development and food production and build people capacities, giving due consideration to gender and nutrition-sensitive perspectives.

National and regional capabilities: There is need to develop national and local bodies that can deal with food security related climate change issues via improvement in extension services; provision and availability of weather and climatic assessment tools with risk management capacities.

National and international investment cooperation: International cooperation should be improved along with public and private investments to ensure food security in response to climate change.

Initiatives in coordination with international organizations:

Implementation of relevant initiatives in coordination with international organizations as institutes to create conditions to facilitate access to genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising from their use.

Inviting the International Commission (i.e. FAO): International summits should be called and invite international commissions on food security to share mutual experiences between countries. This will be helpful to get accessibility to genetic resources and strengthening the food policy (including conservation and use of genetic resources in adapting the climate change).

Consider gender equality in food security issue: Taking into account gender-sensitive and participatory approaches that enable both men and women to gain equitable access to land use, information, and resources when addressing food security in the context of climate change.

Reaching vulnerable rural people with useful information:

Extension services should encourage farmers for adopting modern practices, improving livestock productivity and the use of manure and improving water management.

Promoting insurance schemes for climate change risk:

Innovative insurance scheme are needed for global reinsurance fund for climate changes.

Increase research opportunities: Research activities should be enhanced with improvement in information collection and sharing by increasing international cooperation and public and private investment for research.

Improve food chain process: Make efficient food chain system to reduce losses due to post-harvest. In addition to this, make effective strategy to food waste in a sustainable manner.

Energy security framework and recommendations

Generally, energy security refers to the amount of energy consumption taken from renewable internal means; thus, it is not imported. It is obvious that changes in temperature, precipitation, sea level, and frequency and intensity of extreme events will ultimately affect the energy production, supply and consumption. Energy is used for different purposes, for example, for lighting and cooling, heating, fuel for transportation and cooking. Production of energy and its use is linked with many other aspects of modern life, such as economic growth, water consumption, land use, use of goods and services, transportation and population growth. Climate change will likely determine amount of energy to be consumed as well as our ability to produce electricity and deliver it reliably. According to National Economic & Environmental Development Study, the share of oil and natural gas will decline, while the share of renewable and nuclear energy is considered to be increasing by 2030. The share of coal is expected to be 19% in 2030 as compared to 7.6% in 2005 (Table 2). The preferences for mitigating climate change are wide in the energy sector for both the production as well as supply aspects. For energy demand, main focus is on the transport, residence, as well as industrial sector while for supply side, shifts in the fuel mix (renewable energy promotion) and efficiency enchantments is focused^{8,9} (Figure 3).

Table 2 Energy demand projections by fuel in Pakistan's energy security action plan

	2005		2030	
	Mtoe	Share (%)	Mtoe	Share (%)
Oil	16.33	29.4	66.84	18.5
Natural Gas	28.17	50.8	162.58	45
Coal	4.22	7.6	68.65	19
Hydro	6.13	11	38.93	10.8
Renewable	0	0	9.2	2.5
Nuclear	0.67	1.2	15.11	4.2
Total	55.5	100	361.31	100

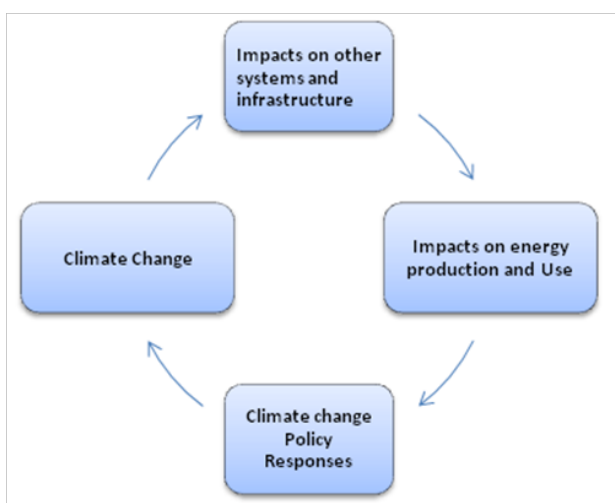


Figure 3 Flow diagram of change in climate and its impacts.

Recommendations

National energy policies: National energy policies particularly renewable energy policies include planning for excess capacity, an explicit pro-poor dimension, the projection to maximize the utilization of renewable energy sources, and the building of reliable statistical databases, are needed to be made.

Promotion of renewable energy: the increased use of renewable energy should be part of the development program, raising political commitment to its promotion. It will require more political will and commitment to achieve the successful implementation of these energy plans.

Special policy packages: Governments should apply specific policy packages and tax incentives to promote energy efficiency and renewable energy projects.

Development of laws and legislative action plans: Government should take legislative actions to criminalize the theft of electricity. To be fair, law enforcement must be aligned with the explicit, pro-poor dimension to be included in energy planning.

Promote research and study fields for biofuel production: there is need to run research projects and enhanced studies on biomass applications for electricity generation could be carried out at the domestic level, taking into account possible GHG emissions and agricultural and infrastructural development. Production of biofuel crops should be focused to meet the energy demand from all available resources.

Awareness campaigns: Campaigns for increasing the awareness of the population on energy savings and the necessity for extensive use of renewable energy sources.

Conclusion

Environmental changes are continuous affecting food and energy demand in the world. In the light of growing population issue and related increased food and energy demand in Pakistan, there is need to develop long-term policies at Government level to fight hunger and stabilize the energy supply. These key issue are playing important role in the economic stability of the country. Future framework will be helpful in addressing and mitigating the possible effects of the climate change on food and energy in context with their demand and supply.

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Conflict of interest

The author declares no conflict of interest.

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