

Water-related impacts on agriculture due to climate change: a review with reference to Kerala.

Impactos relacionados con el agua en la agricultura debido al cambio climático: una revisión con referencia a Kerala.

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ABSTRACT

Climate change has arisen as the most pressing global challenge of the 21st century. The impending challenges may be associated with water resources management. Water-related impacts due to climate change are ranging from water scarcity to intense floods. The state of Kerala has witnessed severe floods in the last two years owing to Extreme Rainfall Events (ERE), among which the prominent ones are the events that occurred in August 2018. The extent of human and livestock mortalities, crop damages and economic losses due to the floods was enormous. This paper critically reviews the scientific studies and reports on impacts of climate change which profiting generalists bothered with environmental challenges. The article highlights the need for water conservation, risk management, and the development of mitigation measures to cope with the water-related impacts of climate change on agriculture.

Keywords—climate change, flood, drought.

RESUMEN

El cambio climático ha surgido como el desafío global más urgente del siglo XXI. Los desafíos inminentes pueden estar asociados con la gestión de los recursos hídricos. Los impactos relacionados con el agua debido al cambio climático van desde la escasez de agua hasta las inundaciones intensas. El estado de Kerala ha sido testigo de graves inundaciones en los últimos dos años debido a los eventos de lluvia extrema (ERE), entre los que destacan los que ocurrieron en agosto de 2018. El alcance de la mortalidad humana y ganadera, los daños a las cosechas y las pérdidas económicas debidas a las

inundaciones fue enorme. Este artículo revisa críticamente los estudios e informes científicos sobre los impactos del cambio climático que los generalistas lucrativos se preocuparon por los desafíos ambientales. El artículo destaca la necesidad de la conservación del agua, la gestión de riesgos y el desarrollo de medidas de mitigación para hacer frente a los impactos del cambio climático relacionados con el agua en la agricultura.

Palabras clave: cambio climático, inundaciones, sequías.

INTRODUCTION

Climate is the long term average weather conditions in a place, which exercise some controls and effects on agricultural production either directly or indirectly. The topic of climate change and variability has received focused attention in recent years from the international community. There is incontrovertible evidence that the world's climate has been changing. If we consider the past 50 years, nine out of ten natural disasters around the world have been caused by extreme weather and climate events. Extreme climate events like storms, floods, droughts, heatwaves, wild-fires, sea -level rise, and other natural hazards threaten the lives and livelihoods of millions of people worldwide. Climate change is the mother of all externalities, bigger, more compound and more unsure than any other environmental problem and also a long term problem.

CLIMATE CHANGE AND AGRICULTURE

Agriculture can be defined as the process of using natural resources (sunlight, air, water, and soil) to make a consumable product (e.g., food, fuel, and fiber), by carry on sufficient resources for the future generation. Agriculture is an economic activity that is highly dependent upon weather and climate to produce the food and fiber required to support human life (Yohannes H, 2016). Agriculture is not only vulnerable to climate change but also one of the major drivers for climate change. Climate change affects agriculture in different ways, such as changes in average temperatures, rainfalls, and climate extremes with an important impact on soil erosion (i.e., floods, drought, etc), changes in pests and diseases, changes in atmospheric carbon dioxide, changes in the nutritional quality of some foods, changes in the growing season, and changes in sea level (World Bank, 2008). The effects of extreme climate events on crops are very severe and may lead to considerable loss to agricultural production that will challenge food security. Water resources are affected by changing climate conditions such as rainfall, temperature, and humidity, which has great impacts on agriculture.

The International Fund for Agricultural Development (IFAD) has said that climate change would push 100 million people into the abyss of poverty by 2030. Close to half of these would be due to climate change's impacts on agriculture. Climate change impact on crop yield is different in different areas, in places it will increase, in others it will decrease which is dependent on the latitude of the area and irrigation application. The impact of climate change on crop yield can find out either by experimental data or by crop growth simulation models such as CERES-Maize, CERES-Wheat, SWAP, and InFoCrop. Climate change has an economic impact on agriculture, it includes changes in farm profitability, prices, supply, demand and trade.

The effect of climate change on agricultural productivity and food security may be finding out by a structural approach which is a union of many tools and methods. There are three major components of the structural approach is physiological studies, crop models, and economic models. The combination of climate, crop, and economic models permit estimating changes in yields and other parameters like biophysical and socio-economic factors. Agricultural production depends upon three factors such as environmental, socio-economic and bio-physical.

IMPACTS OF CLIMATE CHANGE ON INDIAN AGRICULTURE

Climate change impact agriculture all over the world, but India are more vulnerable because of the high population, depending on agriculture and excessive pressure on natural resources. India is a country where water is distributed unevenly and large areas are underwater stress. Among 28 states, most of them are arid and semi-arid lands. Water scarcity /stress is one of the constraints for sustainable development. The impacts of climate change for India are big with extreme weather conditions. Changing rainfall patterns, droughts, groundwater crisis, glacier melts, sea-level rise and floods create challenges to agriculture and food security, energy security, water security and public health. India's agriculture is highly dependent on monsoon from the olden periods. Any change in the monsoon trend extremely affects agriculture. India has a vast geographical area with different agro-climatic conditions, approximately 15 agro-climatic zones.

IMPACTS OF CLIMATE CHANGE ON AGRICULTURE IN KERALA

Kerala state has a long narrow coastal belt and a vast stretch of hilly terrain and forests in the Western Ghats region. It also facing the impacts of climate change like floods, droughts, loss of biodiversity and natural resources, impact on health, etc. Kerala got plenty of water from 34 lakes and other small streamlets, numerous backwaters and water bodies and 44 rain-fed rivers flowing over the terrain of the state. Kerala state also

receives sufficient annual rainfall of 3000mm. Kerala state probably facilitates agriculture to a great extent. Due to climate change, there is a change in seasonality and the amount of water flow from river systems. Climate-related issues over Kerala are a decline in forest area, forest fires, declining in wetlands, indiscriminate sand mining, indiscriminate landfilling, groundwater depletion, floods and droughts, landslides, rainfall decline, temperature rise.



Fig 1: Agriculture map of Kerala

Agriculture is an important subsector of the primary sector of Kerala's economy. Still a majority of the population in the state are directly or indirectly dependent on agriculture for their livelihood. Changes in temperature, precipitation, carbon dioxide, fertilization, climate variability and surface water runoff are the main five factors that affect Kerala's agriculture. With different topography of Kerala, a different type of farming is practicing in low land, mid land and high land of Kerala. In low land rice and coconut are the main crops while rubber, spices, coffee and tea are in high land. In mid land rice, tapioca, coca, clove, nutmeg, ginger, pepper cashew, arecanut etc. are cultivating (Kerala State Action Plan on Climate Change, 2014). The diversity of Kerala's agriculture sector makes distinctive opportunities and challenges with regard to climate change.

Extreme weather conditions like drought, flood and other climate variability have had a major impact on the agricultural sector. Climate change is probably the most complex and formidable environmental problem faced by the world today and is increasingly recognized as a potent threat to agriculture in general and food security in particular. Rising uncertainties in monsoon rainfall and the rise in maximum temperature

have a shadow over agricultural activities in Kerala. Kerala's main crops like rice, cashew, cocoa, coffee, tea, cardamom and black pepper are under threat.

Rainfall data from the IMD stations of Kerala for the period from 1871 to 2008(140 years) revealed that there is a declining trend in annual and southwest monsoon rainfall during the last past 60 years and an increasing trend in post- monsoon rainfall, which indicates likely shifts in rainfall patterns. A study on seasonal precipitation patterns in Kerala during the last five decades (1954-2003) showed that the seasonal extremes in rainfall cause floods and water scarcity which are indicators of climate change. The untimely rain in Kerala, which affect the entire region since 2008 and has caused crop damage and flooding. Experts suggest that untimely rain is clear proof of climate change.

In the middle of August 2018, Kerala went through a severe flood, which was similar to the food in 1924 nearly a hundred years ago (Onmanorama, 2018). Just in 24 hours rainfall was 310mm, which ultimately result in devastating flooding, causing significant damage to infrastructure, agricultural systems and human life. Two years earlier in 2016, both the southwest and the northeast monsoon reduced in Kerala, as a result of which there was water shortage in the summer of 2017.

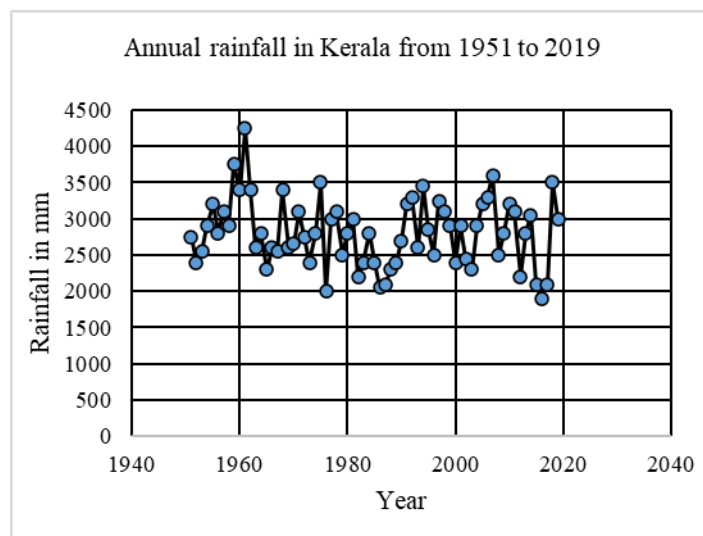


Fig 2: Annual rainfall in Kerala

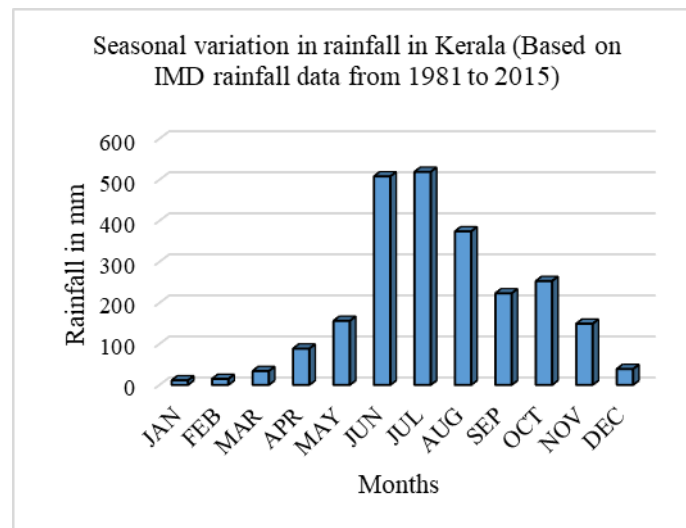


Fig 3: Seasonal variation in rainfall in Kerala

FLOOD IMPACTS ON AGRICULTURAL SECTOR

Floods bring biological and chemical pollutants, which might eventually contaminate the groundwater. Flooding events often source of soil erosion associated with chemical pollutants such as organic and inorganic matter, including heavy metals and polycyclic aromatic compounds, which pose threats to groundwater sources and may be taken up by crops and other plants (Ciesielczuk et al., 2014). Both fertilizers and flooded soils are sources of polycyclic aromatic hydrocarbons (Ciesielczuk et al., 2014). Climate change can increase the frequency and intensity of floods, droughts and heatwaves within a country or at a regional level, and their appearance is uncertain (Greenough et al., 2001).

Approximately half of the population in Kerala live in rural areas and are dependent on rural livelihoods such as farming. Due to the flooding, major crop systems in the state have been negatively impacted, with the plantation industry at risk of losing up to millions and 40% of the current crops. Rice paddy was the worst effected one, with 26,106 hectares of farmland damaged. The flooding has also been reported to have affected tea, rubber, cardamom and black pepper plantations, with an estimated 500 acres of plantation land having been destroyed due to landslides. Production areas and soil fertility are severely impacted due to floods.

The loss due to floods can be assessed in two to three ways. The first one is the sudden crop loss, which means instant loss due to flood. Then there is an ecosystem loss, which is considerable. In the second case the topsoil has been significantly washed out in the mountainous districts of Kerala i.e., Idukki and Wayanad. That causes changes in the chemical and physical structure of the soil, which can cause two kinds of issues. While in most of the places the indication is unfavorable, in some areas it is positive. In many places, silts have collected over the soil. This blocks the oxygen supply to the soil.

In many other places micronutrients have disappeared. We can observe changes in the values of manganese, magnesium and phosphorus and a widespread decrease in boron values. In some places, the soil has converted into acidic nature. All these need area-specific interventions. Then this may lead to losses to the perennial crops – nutmeg, cardamom, rubber, coffee and coconut.

DROUGHTS IMPACTS ON AGRICULTURAL SECTOR

The damage caused by climate change will increase as temperatures rise, and the Intergovernmental Panel on Climate Change (IPCC) warns that it will “disproportionately affect disadvantaged and vulnerable populations through food insecurity, higher food prices, income losses, lost livelihood opportunities, adverse health impacts, and population displacements”. The instant consequence of drought is predictable which may be the decrease in agriculture production and income.

Data collected between 1961 and 2003 from the National Data Centre of IMD, Pune (Indian Meteorological Department) shows that the mean annual maximum temperature over Kerala has risen by 0.8°C and the mean annual minimum temperature has risen by 0.2°C. The average increase is 0.5°C. Unprecedented events of heatwave conditions were reported in many parts of Kerala State during the summer months. The maximum temperatures recorded in many parts of the State either crossed or reached near the critical level of 40 °C, leading to unpleasant living conditions. These temperature rises lead to water shortages and droughts. Deficiency of rainfall adversely affects most the perennial crops hence the summer drought affects most of them in Kerala (Rao, 2010). Drought is the major constraint for crop productivity. Droughts and water shortages across India have a broad and complex impact, which is not limited to agricultural workers.

Records show that almost all the plantation crops suffered to a great extent in 1983 and 2004 due to disastrous summer droughts. A clear shift was noticed from food grain crops (Paddy) to non-food grain crops in Kerala over a while (1952-2008) due to frequent floods in monsoon season and droughts during the summer season. During summer 2004 adversely affected thermo-sensitive crops like black pepper and cocoa in Kerala (Rao, 2010).

DISCUSSIONS AND CONCLUSION

In the last one-hundred years, Kerala experienced a decrease in annual and monsoon rainfall and an increase in temperature at the regional scale. Year-to-year variations in the beginning, amount and distribution of monsoon rainfall are likely to be influenced under projected climate change scenarios. The State of Kerala is situated in the humid tropics with plenty of rains and greenery, where severe summer droughts

were noticed in 1983, 2004 and 2017 during which the surface water resources became rare, led to hydrological droughts and the State's economy was hit very badly. Drought during summer 2004 over Kerala, led to an increase in maximum temperature of 1-3°C during February-March and thermo-sensitive crops like black pepper, cocoa and cardamom across the high ranges and several other perennial crops suffered so much. In 2007, heavy monsoon rains prolonged the crop season and adversely affected the paddy production. Again, unusual rains in March 2008 destroyed the rice, when it was in the harvesting stage. Sunburns were noticed during March 2010 due to the high intensity of radiation and maximum day temperature in Palghat district, which was extraordinary in Kerala. In July and August of 2018 Kerala was brushed by heavy monsoon rains and large parts of Kerala were devastated. Economic losses from the 2018 floods in the Indian state of Kerala alone exceeded damage from all flooding in India in 2017 and reduced real GDP growth in the state by 1%.

The economic and social consequences of recent droughts and flooding in Kerala are enormous, and both the frequency and intensity of these kinds of extreme weather events are projected to rise. Introduction of heat resistant and flood (or drought) tolerant crop varieties as well as more yield- and water-efficient crop varieties, drought-resistant grasses, and plants in urban areas should be introduced to conserve water. Changing of sowing dates, changes in the cropping sequence, irrigation and agriculture land use can be options for adaptation in agriculture. Modern technologies in agriculture could also be helpful with or without climate change; government should encourage farmers to shift towards newer technologies. The government should also encourage research on developing crop varieties that can resist climate change.

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