

Impact of Climate Extremes on the Livelihood

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Abstract : The terms “climate change”, “climate extremes” and “global warming” are often used interchangeably to refer to essentially the phenomenon of rapid changes in earth system dynamics that have been occurring at an increasing rate over the past two or more centuries. Climate extreme events are occurring mostly due to climate change in the last decade. Historical background of climate extremes and their causes has been focused. Impact of climate extremes on agriculture, forestry, fisheries, population displacement, poverty, gendered livelihood, decreased labor productivity has been analyzed. Environment is something we are trustees of and have to leave behind a better environment for our children.

Keywords: Climate change, climate extremes, impact on livelihood, global warming, agriculture sector

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1. Introduction

The terms “climate change”, “climate extremes” and “global warming” are often used interchangeably to convey to essentially the phenomenon of rapid changes in earth system dynamics that are occurring at an increasing rate over the past two or more centuries. The past decade (2011-2020) was warmer by 1.09 °C than the period from 1850 to 1900 and also the 1.5 °C heating threshold is probably going to be breached soon (Anand, 2021). From 1970 to 2012, 8,835 weather, climate and water related disasters were reported globally. Together they caused a loss of 1.94 million lives and economic damages of US\$ 2.4 trillion (WMO, 2014). India has

witnessed 478 extreme weather events between 1970-2019 and most of them occurred after 2005 (Mohanty, 2020).

2. Categories of Weather and Climate Extremes

The different categories of weather and climate extremes include

I) Extremes of atmospheric weather and climate variables (temperature, precipitation, wind)

II) Weather and climate phenomena (monsoons, El Nino and other modes of variability, tropical and extra tropical cyclones)

III) Impacts on the natural physical environment (drought, flood, extreme sea

level, waves, landslides, dust storms (IPCC, 2012).

2.1. Heat spells

Heat extremes are often considered as warm season hazards, but anomalously warm temperatures during the cool season can even affect agricultural and natural systems. Recently, the Laptev Sea experienced a very intense marine wave from June to December, 2020 (WMO, 2021b).

2.2. Extreme Rainfall

Extreme rainfall suggests changes in daily extreme or heavy precipitation events. Floods are the foremost common natural disasters in terms of economic damage. In August 2018, Kerala experienced the foremost devastating floods in the history of the state, leading to the loss of 474 lives. One sixth of Kerala's population has been directly stricken by the floods and related incidents (GOK, 2020).

2.3. Drought

It is a period of abnormally dry weather long enough to cause a heavy hydrological imbalance. As an example, shortage of precipitation during the season impinges on crop production (agricultural drought) (IPCC, 2012). Highly drought vulnerable districts are from the Central Maharashtra Plateau Zone as Sangli has the best exposure to socio-economic vulnerability index to temperature change (0.62) in Maharashtra, India (Adhav *et al.* 2021).

2.4. Thunderstorms and Cyclones

Severe thunderstorms include phenomena such as tornadoes, lightning, hailstorms, high speed wind, dust storms, waterspouts and downpours. Tornadoes produce the strongest winds observed on the surface of the world with speeds reaching 500 km/h. The warm tropical oceans spawn the foremost formidable storms in the world. They evolve from clusters of thunderstorms called tropical disturbances. The strongest tropical cyclones have sustained

winds greater than 195 km/h and wind gusts greater than 280 km/h; as they produce widespread destruction (WMO, 2002). In Bangladesh, the tropical cyclones and storm surges in 1970 (Bhola) and 1991 (Gorky) that led to almost 3,00,000 and 1,40,000 casualties, respectively.

2.5. Cold spells

In Mongolia during January 2001, blizzard conditions with winds of more than 100 km/h froze 12 herders to death, contributed to the death of 4,67,000 animals and drove another 33,000 away onto the steppes. Most of those extra deaths were not caused by hypothermia but by cold aggravating circulatory diseases (leading to strokes and heart attacks) and respiratory diseases like bronchitis and pneumonia (WMO, 2002).

3. Causes of climate extremes

- 1) Natural causes- continental drift, volcanoes, the earth's tilt, ocean current
- 2) Anthropogenic causes- global CO₂ concentration, ocean acidification, global surface temperature

3.1 Natural causes

The Himalayan range is rising by about 1 mm each year because the Indian land mass is moving towards the Asian landmass, slowly but steadily. When a volcano erupts, it throws out large volumes of sulphur dioxide (SO₂), water vapor, dust, and ash into the atmosphere. The gases and dust particles partially block the incoming rays of the sun, resulting in cooling. The earth makes one full orbit round the sun annually. It is tilted at an angle of 23.5° to the perpendicular plane of its orbital path. Because of the tilting, we experience half of the year summer and the rest of the year winter. About 25–30 per cent of CO₂ emissions is absorbed by the ocean leading to ocean acidification (WMO, 2021b).

3.2. Anthropogenic causes

The global atmospheric carbon dioxide concentration has increased from an average of 280 ppm within the pre-industrial period to over 407 ppm in 2018 (Krishanan *et al.* 2020). Carbon dioxide (CO₂) is the primary greenhouse emission from anthropogenic emissions. Ocean acidification is linked to a decrease in carbonate ion concentrations, which are necessary for marine organisms, like mussels, crustaceans and corals, to make shells and skeletal material. Depending on the greenhouse gas concentration pathway scenario, global mean surface temperature (GMST) rise is predicted to extend by 2–5 °C by the year 2100. Warming of land and surface air temperature ends up in heat extremes and heat waves which are increasing in both frequency and intensity worldwide, fuelling large and devastating wildfires (WMO, 2021b).

4. Impact of Climate extremes on livelihood

4.1. Agriculture

4.1.1. Food Security

In the heavily populated countries of Asia and also the Pacific, the share of people dependent on agriculture ranges from 40 to 50 percent, and in sub-Saharan Africa, two-thirds of the working population still make their living from agriculture. Devendra (2012) studied the impact of climate change on Asian agriculture and reported that there will be an increase in prices of agricultural products, over the next 10 years the costs are going to be 15-40 per cent more than that in 1997-2006. Kuwayama *et al.* (2019) studied the impacts of drought by the U.S. Drought Monitor (USDM), on crop yields and farm incomes in the United States during 2001- 2013 and they observed negative and statistically significant effects of drought on crop yields equal to reductions in the range of 0.1 per cent to 1.2 per cent for corn and soybean yields. Benny (2020) studied that because of extreme weather events in 2018

about 42.09 per cent of expected yield was lost to farmers and only 518.49 kg per ha of cardamom was the harvested yield in Idukki district. Maximum temperature and rainfall during the initial growth phase of rice crop in Kuttanad region of Kerala are exerting significant positive effects on farm income while these variables during the second phase of crop growth cause a decline in income (Susha, 2011).

6.1.2. Livestock

Impact of unseasonal rains and hailstorms during February–April 2015 on the many thousands of birds, especially peacocks, were found dead in fields after the hailstorms and many cattle were seriously injured. The hailstones were so heavy and fell with such velocity that they broke cemented roofs in several villages. Some hailstones weighed maximum amount of 1–2 kg. (Chandra *et al.*, 2015).

6.1.3. Fisheries

Global fisheries stand to lose approximately \$10 billion of their annual revenue by 2050 if global climate change continues unchecked, and countries that are most dependent on fisheries for food are going to be toughest hit (UBC News, 2016). Ocean acidification affects marine organisms like mussels, crustaceans and corals. Coral reefs not only function in all the foremost bio diverse ecosystems in the world, but also provide essential shoreline protection in case of high waves or storm surge and serve as habitat for many important shellfish and other invertebrates (WMO, 2021b).

6.2. Population Displacement (Refugees)

Much of the disaster-related displacement recorded globally in 2020 took place in China, Bangladesh and India, which recorded some of the highest figures (about 4 to 5 million new displacements each) (IDMC, 2021).

6.3. Economy and infrastructure at high risk

In Vietnam, impacts from weather and climate disasters, like typhoon Damrey in November 2017, can result in a major reduction of GDP, e.g., about one percent point of annual growth, with the agriculture sector being the worst affected. Climate change would reduce national income by up to an estimated 3.5% by 2050 (WMO, 2021).

6.4. Poverty

Among disadvantaged people in urban areas, poverty traps are reported especially for wage laborers who erode their financial capital because of increases in food prices (Ahmed *et al.*, 2009). About per cent change in poverty once in 30 year climate extreme was more in non-agricultural sector and urban labour about 11.8 per cent and 30 per cent respectively.

6.5. Gendered livelihood impact

Men and women are differentially affected by climate variability and change. In India, more women than men, especially women of lower castes, work as wage laborers to compensate for crop losses. Climate variability amplifies food shortages within which women consume less food (Lambrou and Nelson, 2013).

6.6. Labour and economic productivity

Production losses in climate-sensitive industries, increased workplace accident risks and heat-related illnesses contribute partly to the present phenomenon. Studies have identified decreased labour productivity as a serious factor affecting economic growth in a very majority of countries (WSR, 2020). Female labourers have about 70% and male labourers have 57% coping strategies which are highest among migrants, who migrate to neighbouring villages for work and take loans.

7. Livelihood Adaptation strategies

7.1. Agriculture

a) Crops

Provide seed packages of drought tolerant variety crop species. Distribute more resistant coffee and pepper varieties through improved seedlings as replacements for plantation. Under the technology demonstration component of the National Initiative on Climate Resilience Agriculture a number of varieties were demonstrated to farmers in various flood/ drought prone regions of the country. Varieties of deep water tolerant rice are SwarnaSub-1, Jalnidhi, Neerja, etc. and sugarcane (Co 98014, Co 0238, etc. were demonstrated (PIB, 2015).

b) Livestock

Restock poultry (vaccinated), provision of additional feed, vaccines and treatments to protect animals. Distribute fodder and drought-tolerant seeds for fodder production. In the disaster management plan (2020), the department of animal husbandry and veterinary services planned safe stocking of the feed and fodder for emergency supply (GOG, 2021).

c) Fisheries

Restock fish/ shrimps and their feed to small scale aquaculture farming households.

7.2. Livelihood and other related areas

- Establish small and simple storage facilities to preserve the food and agricultural inputs against heavy rains and pests.
- Facilitate low interest loans to provide people readily available “cash in hand” to invest within the restart of agriculture livelihood activities.
- Construct wells, small dams, piped installation in areas vulnerable to continuation of drought and saltwater intrusion, especially for human, livestock and irrigation consumption. (GOG, 2021)

7.3. Long term interventions

7.3.1. Agriculture

a) Crops

- Construct, rehabilitate and expand irrigation infrastructure further as improved irrigation systems to succeed in more beneficiaries and enhance crop production. In Brazil, rice irrigation using a centre pivot system reduced water use by 50 % compared to the surface system, with surface irrigation the full application depth was 1100 mm, while with pivot irrigation it was 550 mm and in the Israel of the 500 million m³ of the wastewater about 50% is treated to secondary level and 40% is treated to tertiary level. The treated wastewater is used for irrigation by blending with freshwater and through drip irrigation. It is obligatory for farmers to obtain permits to use wastewater for irrigation purposes (Kulkarni, 2011).

- Conduct training on crop diversification, water saving practices, pest and disease management (IPM) approach, organic farming and composting by taking into consideration farm field school method. Rayhan and Grote (2010) studied that monsoon flood (Bangladesh, 2005) causes damage to cash crop, to minimize vulnerability having high potential by adapting crop diversification such as ricejute in the flooded districts of Jamalpur and Nilphamari.

- Organic farming is the farming with higher soil availability of major, secondary and micronutrients using farm yard manure (FYM), vermicompost, neem cake combined application (Krishnamurthy *et al.*, 2019).

- Establish cooperatives and farmers associations to increase access to markets and group loans, especially for perennial crop production like coffee, cashew, rubber, pepper.

- Shift crop production towards climate change adapted varieties. ICAR- Indian Agricultural Research Institute (IARI) has

released the high yielding varieties such as HD 2967 and HD 3086 which are grown in North-west and North India.

- Restructure the crop production sector towards climate smart agriculture (GOG, 2021).

b) Livestock

- Highly productive and more drought tolerant improved animal breeds especially regards to cattle, pigs and goats.

- Construct water reservoirs to support livestock production.

- Conduct training on livestock production including disease prevention, composting, advanced rearing practices and livestock diversification (bee production) (GOG, 2021).

c) Fisheries

- Establish additional hatchery facilities in rural areas to boost access to shrimp and fish fishlings as well as reduce dependency on the formal market.

- Develop technical guidelines for better aquaculture cultivation to ensure the quality, productivity and environment protection aspects (GOG, 2021).

- Conduct training on aquaculture production including disease prevention, integration of rice and fish based farming systems (pokkali system) and marketing. The pokkali rice-shrimp rotational farming system prevalent in traditional paddy fields along the coastal belt of Central Kerala is a classic example of sustainable agri- aqua integration providing a means of rural 31 livelihood. The average body weight of tilapia harvested was 294.4 g giving a total yield of 202.88 kg (811.50 kg./ha) and a rice yield of 650 kg (2600 kg./ha) was also obtained (Nair *et al.*, 2010).

7.3.2. Livelihood and other related areas

- Establish new processing facilities for agriculture, livestock and aquaculture sectors in remote production areas to facilitate the transformation of agricultural production, guarantee the freshness and quality of products sold and generate more job opportunities.
- Improve market access by restoring roads and improving transportation facilities.
- Improve the supply chain and added value of agriculture products to increase affected people's resilience (GOG, 2021).
- Provide farm machinery and post-harvest processing equipment to increase production and income as well as reduce losses.
- Create community awareness on early warning and disaster risk reduction systems, management and mitigation as well as adaptation to climate change conditions.
- Establish and strengthen data information management systems for disaster preparedness and early warnings. Based on forecasts by the Ministry of Earth Sciences (MoES), India Meteorological Department (IMD), Department of Space, Indian Space Research Organization (ISRO), Central Water Commission (CWC) and other agencies for various types of disasters, the state will take preparatory steps to ensure disaster preparedness (GOG, 2021).
- Plant local indigenous trees to alleviate the negative effects of drought and other hazards like floods. Maintain wide mangrove belts and to significantly reduce everyday waves, need a belt of many meters wide. For example, in a more open forest, about 500 m of mangroves reduce a wave. Integrating mangroves into coastal defense strategies to reduce such hazards (Spalding *et al.*, 2014).

8. Conclusion

Community preparedness is the only practical solution for countries that are at high risk to extreme weather and climate events. The

global, regional and national layers of the scientific and technological infrastructure that make up the World Weather Watch (WWW) provide an array of knowledge for managing climate risk and reducing vulnerability to meteorological and hydrological hazards. Adaptation strategies are emergency relief measures, short-term coping for the households, early warning systems, drought-resistant crop varieties, all season irrigation infrastructures (Piya *et al.*, 2019). Reduce vulnerability, exposure, and increase resilience to changing risk. Becoming carbon neutral by 2030 is an essential condition for reducing climate-related risks to sustainable development (IPCC, 2012).

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