Current Status of Drought in India and Its Management with Special Reference to Maharashtra

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Abstract

Drought is a common worldwide natural catastrophe. Almost one half of the countries in the globe is situated in drought risk zones. Drought has a major impact on agricultural productivity as well as water availability for household and industrial use. Drought has a gradual impact on the country's economy, but it has a long-term impact. Drought is one of the most serious dangers to people's livelihoods and socioeconomic development among natural catastrophes. It occurs less frequently than other dangers, but when it does, it typically impacts a large area for months or years at a time. India is split into 36 sub-divisions based on weather. The nation is split into 127 agro climatic zones for agricultural planning and development, based on temperature, rainfall quantity, soil, and cropping pattern. Drought is a common occurrence in India's climate, and it is typically defined by its regional extent, intensity, and duration. It has a gradual beginning, unlike other natural catastrophes, but increases in strength with deadly consequences. This paper reviews about the current status of drought in India especially Maharashtra and offers suggestions to manage the drought in future.

***Key words**: Drought, Impacts of drought, Drought mitigation strategies*

1. Introduction

Unlike climatic changes, or even different seasons aridity (in the context of a properly specified dry season), drought is a transitory aberration in the climate that cannot be avoided. Aridity, on the other hand, is a permanent feature of the climate that cannot be avoided. Despite being a common characteristic of the climate, dry spells are a sporadic phenomenon that has been observed to occur even under climatic regimes and to be described by variance in aspects of their intensity, spatial extent, and duration. Droughts, on the other hand, are more consistent in their frequency and duration. The occurrence of drought conditions is primarily, though not exclusively, due to substantial deviation from the normal rainfall pattern, additionally the skewed aspect of the geographic variation, to an extent that has a negative impact on crop over the course of a farming season or over a sequence of agricultural seasons. However, while it is universally acknowledged that drought is due to a lack of or erratic rainfall distribution, it is less widely acknowledged that the expansion and rapidity of the tragedy are dependent on a range of factors, including situation of surface and agro-climatic characteristics, ground water resources, cropping patterns and choices, as well as the social and economic weaknesses of the local population. As a result of the complex nature of drought and its variable characteristics, which emerge individuals in several ways across preparation of a variety regions around the world, it is difficult to provide an exact and generally accepted definition of drought.

Many different definitions exist for drought, including: ‘a period of dry weather' (Nagarajan, 2003); ‘an abnormally dry weather pattern resulting in a serious hydrogeological imbalance, with consequences such as crop losses and water shortages for people and livestock' (Alexander, 1993); and ‘a creeping circumstance of scarcity without replenishment of resources' (Alexander, 1993). (Swami, 2001). Because we have different methods for identifying drought conditions in specific locations and times, droughts can be categorised in several different ways (Roy and Hirway, 2007). The meteorological drought, which is the most widely accepted definition, is associated with the degree of dryness and the length of time that the weather has been dry. Drought conditions are described as having a precipitation deficit that is greater than 25percent of the usual in a specific part of the world. Whenever the precipitation deficit exceeds 50% of the long-term average, it is referred to as severe drought. It is important to note that the meteorological concept of drought does not consider hydrological, ecological, or human-induced factors (Roy and Hirway, 2007; Reddy, 2008). When there is a significant depletion of surface water, hydrological drought conditions occur, resulting in low stream flow and acute drying of ponds, lakes, reservoirs, and rivers, among other effects (Reddy, 2008). Agricultural drought is defined as a period in which insufficient soil moisture causes severe crop stress and has a negative impact on crop productivity (Reddy, 2008). The term "ecological drought" refers to a situation in which the primary productivity of a natural or handled ecosystem declines dramatically over time because of reduced precipitation. Combined with all the other types of droughts, socio–economic droughts occur when precipitation is inadequate to meet the needs of human activities (Roy and Hirway, 2007).

There are many different drought definitions that have been adopted in various fields (meteorology, hydrology, economics of water resources), all of which are based on different hydrometeorological variables. Drought conditions in the weather the most widely used meanings of drought are those based on weather conditions. They frequently describe drought solely based on the degree of dryness and the length of time that has passed since the last rains. The term "climatological drought" refers to a period of more than a specified number of days during which there is no precipitation greater than a specified small amount (Wilhite and Glantz, 1985).

- **Hydrologic Drought**

Instead of focusing on the meteorological explanation for the event, hydrologic drought definitions are more concerned about the effect of dry spells on surface or subsurface hydrology. It is common to define the occurrence and intensity of hydrologic droughts in terms of their impact on river basins, rather than the other way around. It is common for hydrologic droughts to occur out of sync with both agricultural and meteorological droughts.

- **Agricultural Drought**

The term "drought" refers to a period in which soil is lowered to the juncture in which agricultural crop harvests are substantially reduced or eliminated in agriculture. In agricultural climate models, different characteristics of meteorological drought are linked to different aspects of agricultural impacts. These characteristics include lack of rain, deviation from normal, and a variety of meteorological factors such as evaporation (Wilhite and Glantz, 1985). Drought in agriculture is a time of prolonged dryness that affects the moisture status of the soil and prevents the plant growth. The amount of water needed for evaporation and transpiration during a drought exceeds the total moisture content present in the soil, likely to result in an extreme state of dehydration. It occurs because of stress conditions in soils during crop growth because that's what tends to cause it to happen (Reddy, 2008). Dry weather conditions frequently affect food produced in dry regions and semi-arid environments in India. This can cause them to fail, as has happened in the past. Drought-induced water-stress conditions are always linear and progressive in their development. Depending on the differences in seasonal rainfall, the intensity of the drought can range from moderate to severe in severity. The inability of root system to receive good soil moisture rapidly enough just to preserve the crop's actual water balance, whether for stronger or worse, is the starting point, for stronger or worse (Gupta, 1992). When it comes to determining the severity of a drought, the distribution of rainfall is also important (Reddy, 2008).

- **Socio-Economic Drought**

Difficulties in expressing the socioeconomic consequences of drought can be incorporated into definitions that express the characteristics of agricultural, meteorological, and hydrological droughts (Wilhite and Glantz, 1985). It is common for them to be associated with the demand and supply of a particular economic good. According to Yev Jevich (1967), the space and time methods of supply and demand are the two fundamental processes that should be considered when attempting to establish an objective measurement of drought.

Dry spells are distinguishable from other types of natural hazards such as floods and earthquake. They are also distinguished by the fact that they are preceded by volcanic eruption, cyclones, and tsunamis.

- There is currently no universal definition that adequately captures the complex nature of this phenomenon's manifestation.
- A drought episode is difficult to determine when it began and ended drought episodes are characterised by their slow, "awkward" onset, silent spread, and rapid withdrawal that characterise them. In India, it is commonly agreed that it occurs at the same time as the monsoon season.
- It is possible for an episode to last for months or even years, with or without the occurrence of a change in geographical location.
- At this time, there is no true indicator or indices that can correctly assess the initiation and duration of a heavy storm, let alone task the consequences of a drought event.
- The fact that disasters frequently affect a larger geographic region than other natural calamities, when combined with the difficulties in conducting disaster impact assessments, clearly makes disaster response extremely challenging.
- In most cases, the consequences are non-structural and difficult to quantify, among these are environmental impact and society dissolution, disruption of the social and economic fabric of communities, lengthy effects of malnourishment on health and mortality, and a host of other consequences. When there are several consecutive droughts, the impact is likely to be magnified.

2. Literature Review

Smakhtin and Hughes, (2004) reviewed and analysed the existing drought indices to determine whether they were applicable for drought prediction and management in the context. There has been the development of a software package for the automated estimation, display, and impact of different drought indices. The Standardized

Precipitation Index (SPI) is much more widespread used in Southwest Asia than other drought, according to the investigators, due to the limited data input requirements, flexibility, and ease of calculation.

Moreira et al, (2008) By utilizing loglinear models, we developed an SPI-based drought category prediction system. Using data from 14 rainfall stations in the Alentejo and Algarve regions of southern Portugal, loglinear modelling for 3-dimensional values of the variables was used to make short-term drought severity predictions. A 12-month time scale was used to transform drought classes derived from weekly, daily, and monthly SPI time series. We computed odds for each class of drought to fully understand drought evolution and approximate transition probabilities between drought classes. It was necessary to conduct drought simulations between 2004 and 2006 to validate the predictions.

Cemek et al., (2011) Drought is the most hazardous natural hazard in terms of performance, and its severity varies from region to region and from time-to-time period. The connection between soil moisture, crop yield, and evapotranspiration is well-established and well-documented. It is based on the soil moisture and evaporation and transpiration of a region to predict and monitor droughts.

Pai et al., (2011) It has been discovered that SPI is suitable for examining drought on a monthly scale in various districts across India. This has been done in various districts across India using SPI. Several time scales (1, 3, 6, and 12 months) were used in the past to identify a region's meteorological drought, with the most common being the SPI and SPEI indexes.

Motha, (2011) In developing and implementing extreme weather policies, the plant yield forecast is critical. Crop simulation models are mathematical equations that describe crop growth, output, climatic conditions and providing facilities in each area. In several crops (rice, wheat, maize, etc.) many investigators have used the designed to simulate model approach with beneficial results in various crops. It has been determined how well crop prediction models perform in both drought and non-drought years in several different locations around the world. In this model, weather, soil water, genetics, carbon, and nitrogen effects are all considered to simulate crop growth, advancement, and yield.

Wuttichai et al., (2011) In India and its neighbouring countries, agriculture provides most of the economy and means of subsistence for the population. Rainwater-based agriculture in India and Myanmar depends heavily on the soil amount and type of soil humidity available. Because crops in the Indian region are rainfed, the success of an agricultural crop is highly dependent on precipitation. The variability of rainfall during the monsoon season has an impact on India's total crop yield as well as the country's economy.

Miralles et al., (2012) compared the use of satellite-derived moisture differences to describe extremes of temperature. There have been numerous studies that have used soil moisture data to better understand climate variability. These studies have compared the reaction of soil respiration to soil moisture and temperature as well as N fertilization during this time and found that it is beneficial in terms of both temporal and spatial variability in soil respiration.

Saha et al., (2015) The drought in Surat district was examined using SPI and observed rainfall data from the previous four decades. have investigated the Mann Kendall Trend Test using a representative SPI from each of the agro-climatic zone (ACZs). A significant trend was discovered in six of the ACZs during the JJAS, according to the research team. It is notable that during the month of June, the Trans-Gangetic plain experiences a significant increase in wetness, while the west coast plain and hills exhibit the characteristic feature of a significant increase in wetness with an increasing trend of dryness during the month of July.

Ficklin et al., (2015) In addition, the PDSI is used in many studies to examine drought conditions. when air temperatures are higher than normal in relation to climatology, the Thornthwaite potential evapotranspiration (PET) method is used to calculate a PDSI, it is discovered that the PDSI is overestimated in drought conditions. As air temperatures around the world rise above normal, the Thornthwaite PET way to calculate the PDSI may no longer be a viable option, according to the authors of the study. Therefore, several scientists proposed that the Penman–Monteith PET method has been used to estimate PDSI in each geographic area.

Singh et al., (2016) Many studies have observed a yield gap among observed and simulated results in rice and wheat crops and found errors in the DSSAT module on the soil water balance and proposed changes to increase model forecast accuracy in the past. The cropping system is designed to be significantly complex, and crop production varies in both space and time. A CERES-Rice sensitivity analysis was conducted, and it was found that the maximum, average and minimum temperatures, or rainfall directly relate to the crop yield observed. They found that higher temperatures adversely affect crop yield in their studies.

Mondol et al., (2017) Using the SPI method, over 30 meteorological stations in Bangladesh were used to identify the meteorological drought that occurred between 1981 and 2010. The findings also showed that on average, a drought occurs in Bangladesh every 2.5 years. They have identified some particularly severe drought years in Bangladesh, including 1981, 1982, 1985, 1987, 1989, 1992, 1994, and 1996, 2004, 2006, and 2009.

3. Impact of Drought

Drought has far-reaching consequences that affect a wide range of economic sectors and areas of the economy. Because agriculture and water supplies are critical to our capacity to produce more goods and services, the repercussions of drought are felt far beyond the borders of the areas that are having experienced the onslaughts of physical drought. Difficulties in the economy of the country are caused by drought, which has an impact on the macro and microeconomic levels, both direct and indirect. Agricultural production has been reduced, resulting in increased food insecurity amongst these poor and vulnerable. Water levels have been depleted, leading to increased wildlife mortality, and livestock cattle migration, harm to the eco-system from reckless exploitation, increased fires, and other resulting effects. In order to assess the indirect effects of drought, it is necessary to consider the following factors: decreased incomes for farmers and seed companies, a boost in food and fodder prices, a decrease in purchasing capacity and a decrease in consumer spending, default on farm loans, despondent sales of agriculture sector livestock, rural unrest, and a reduction in agricultural employment opportunities There is a significant negative multiplier effect in the economy and society as a result of these harmful impulses. Drought has a variety of consequences that can be divided into three categories: environmental, economic, and social.

Drought-related impacts are typically extensive and comprehensive in nature, and they can be difficult to distinguish from other causes. Another factor contributing to the problem is the reality that drought is always treated as a "crisis situation" and as a short-term problem. The perception of drought among individual people at the household scale is that it is a major phenomenon which is beyond human intervention. Throughout the country, the drought influences the economy, both at the micro and macroeconomic levels, as well as on agriculture. It can occur itself in either a direct or indirect manner, and the nature and intensity of the effect vary based on the location. Difficult factors like economic conditions, agricultural sector patterning, irrigation management, the accessibility of cereal reserves (both domestic and international), conflicts within and between countries, and so on, all effect the severity and intensity of the drought's impact and its consequences. On a micro–level, the ability to produce and obtain food has a major impact, and this is reliant on factors such as social structure, village and class structure, and domestic resource endowments among other things. The unique features of each region, on the other hand, would compare the exact and truth magnitudes of each impact. Droughts result in the loss of assets such as livestock, crops, and productive capital when there is a water shortage, which are the direct impacts of water scarcity. Droughts also cause the death of livestock. The lingering effect is felt in the subsequent season, when there is a scarcity of high-quality seeds (NDMG, 2010). Conditions like famine are created in areas of the affected region or state that are suffering from acute drought conditions. According to (Samra and Singh, 2002; Samra et al., 2006; Reddy, 2008; and the DAC of the Government of India in 2009). Drought's economic, environmental, and social consequences are generally divided into three categories:

A. **Economic impacts:** Agro-economic losses refer to reduced productivity in agriculture and related sectors, particularly dairy, poultry, animal husbandry, horticulture, and fisheries, among other things. It has a negative impact on the livelihoods and life quality of most sharecroppers, farmers, artisans, farm labourers, small rural businesses, and the rural population in general who are reliant on agriculture. Because of reduced supplies and hardening prices in the primary sector, all industries that rely on raw materials from the primary sector suffer. Because of the disruption caused to supply chain, the economy suffers from a dampening effect that includes reduced industrial and consumer demand, increased reliance on imports, and a lowering of overall market sentiment. Drought also has a negative impact on the environment by reducing the availability of fresh water and decreasing the availability of clean drinking water.

B. **Environmental impacts:** Climate change has indicated decreased water levels on land and ponds and lakes, surface reservoirs, decreased flows from rivers and streams, springs, loss of forest cover, migration of wildlife, escalation of human-animal conflicts and mental anxiety on biodiversity. Reduced flow rate and wetland disappearance may influence salinity. Greater groundwater depletion rates and reduced recharge have the potential to damage aquifers and negatively impact water quality (e.g., salinity, acidity, dissolved oxygen, turbidity), which may result in a potential loss of biological productivity in soils over the long term.

C. **Social impacts:** Rural society has seen widespread social disruption, due to exodus of people from drought areas, the rise in drop-out rate at school, increased poverty and debt, land alienation and malnutrition, the depreciation of livestock resources, malnutrition, and social deprivation among some of the most vulnerable groups. The presence of scarcity can exacerbate tensions and contribute to the exhaustion of social capital in some circumstances.

➢ Impact of Drought on Agricultural Field Crops

- Field preparation and other cultural operations, as well as the sowing and planting of field crops and the establishment of crops, are all delayed or prevented.
- Defeat or destruction of a crop that has already been planted when there is a drought early in the season, the consequences are more severe.
- Crops' susceptibility to various insects, pests, and diseases, as well as their vulnerability to them.
- Plants' physiological and biochemical metabolism are altered because of this.
- Changes in the quality of forage, grain, fibre, and oil, among other things.
- Increased drought severity results in a decrease in the grain and fodder yields of field crops.

4. Drought in India

It was common for droughts to distribute into severe famines during the colonial period, with large numbers of people being killed or starved because of these catastrophes. An estimated 25 food shortages occurred throughout India in the latter half of the nineteenth century, causing between 30 and 40 million people to fall. The first Bengal famine, which took place in 1770, is believed to have scraped out nearly one-third of the country's population, according to historical records. Even though India gained individuality in 1947, the droughts continued, with the Bengal famine of 1943–44, which impacted 3–4 million people, being one of the most devasting of them all (India, M. O. A. 2016).

In the years following unification, the situation in India improved significantly. All of them have led to increased agricultural output and to more resilience in the agricultural community of developing countries through investment for irrigation systems, advancement and availability of high-quality inputs and a strong focus on extension workers. As a result of this growth, the country was not only capable of achieving food independence, but also virtually starved. The population of India has increased since independence, and the country has not encountered a famine in the past six decades. In addition, the nation has identified as a prominent exporter of farm commodities to countries all over the world in recent years.

Following India's economic liberalization of its economy in the 1990s, the agricultural sector's proportion of Gross Domestic product (GDP) began to decrease to less than 15% of GDP (approximately half its share some decades ago), but in food and agriculture commodities the country remained largely autonomous, while becoming more resilient against drought.

4.1. Meteorological History of Droughts in India

Between 1871 and 2015, there were 25 major drought years, which were defined when years from All India Summer Monsoon Rainfall (AISMR) or less than one variance below the mean (anomaly less than ten percent). These were the following years: A list of the years 1873 to 1877; 1900 to 1904; 1905 to 1911; 1918 to 1920; 1941 to 1951; 1965 to 1966; 1968 to 1974; 1979 to 1981; 1982 to 1985; 1986 to 1987; 2002 to 2009; 2014–2015; and 2016. Droughts have occurred more frequently or less frequently over the years. From 1899 to 1920, there were 7 years of drought in the United States. Among the numerous droughts that have occurred since independence, the one that occurred in 1987 was the worst one, with a total rainfall deficit of 19 percent that affected 59–60 percent of the normal crop production and a population of 285 million people. When the total rainfall deficit for the nation was 19 percent in 2002, this pattern was repeated. More than 300 million of people spread across 18 states, as well as approximately 150 million cattle, were affected by the drought (India, M. O. A. 2016).

Droughts have occurred on a regular basis since independence, but one of the worst occurred in 1987, when an overall precipitation deficit of 19 percent resulted in crop failure in 59–60 percent of the standard cropped area, affecting a population of 285 million. This pattern was performed in 2002, when the total rainfall deficiency for the nation overall was 19 percent lower than normal. The drought had a significant impact on more than 300 million inhabitants spread along all 18 states, and approximately 150 million cattle, according to government estimates. It was the first time in the industry's history that food production grains dumped by 29 million tonnes, an unrivalled decrease. As a result, food grain production decreased by 16 million tonnes in 2009 because of the overall rainfall deficit of 22 percent for the country. Large areas of the country were affected by drought in 2014-15 and 2015-16, resulting in widespread hardships for the affected population because the calamity affected major agricultural states in the country.

4.2. Impact of drought in different years in India

The South–Southwest monsoon is responsible for approximately 70% of the annual rainfall in major parts of India. The prospects for agricultural production are determined by the timing of it occurring in normal intensity and uniformity of distribution (Reddy, 2008). The drought of 2002 is widely regarded as the worst in the last hundred years, and it has been dubbed the "most acute drought in recorded history" due to the complete failure of monsoon rains (only 64 mm) from June to August 2002. During the monsoon season of 1987, 102 mm of rainfall was received, compared to an average rainfall of 650 mm in the northern and western parts of India. Its impact on human beings, livestock, and natural resources, especially in the year 2002, has been documented in states such as Rajasthan, Haryana, Uttar Pradesh, Punjab, Odisha, Gujarat, Madhya Pradesh, Tamil Nadu, Karnataka, and Kerala, as well as in other parts of India (Samra, 2004; Safari, 2006). There were signs of reservoir drying, rivers drying, surface water depletion, and soil moisture depletion due to insufficient rainfall. In such cases, groundwater would be unable to meet crop, animal, and human water demands for an extended period (Sinha, 2002; Gautam, 2012). As a result, the amount of land under cultivation was reduced (Sinha, 2002). The Government of India discovered that the area under rice (Oryza sativa L.), pearl millet [Pennisetum glaucum (L.) R. Br. emend Stuntz], sorghum [Sorghum bicolor (L.) Moench], maize (Zea mays L.), groundnut (Arachis hypogaea L.), and soybean [Glycine max (L.) Merr.] was reduced by 5 to 7%.

During the last 120 years (1870–1990), according to Ghosh and Jana (1993), the occurrence of drought in India was at its peak during the period 1901–1925 across 29 out of 35 meteorological subdivisions. Gautam (2002) also stated that the year 2002, which occurred at the beginning of the twenty-first century, will be remembered as the year of severe drought that affected nearly thirty meteorological sub-divisions of India. This drought was strikingly like the droughts that occurred in 1899, 1918, 1972, and 1987. Samra (2002) discovered that approximately one–fifth of the total geographical area is typically affected by drought once every five years and three times every ten years, according to his studies.

The following are the most common causes of this type of natural calamity:

- Prolonged low precipitation, measured in terms of initiation, intensity, duration, persistence, and termination, was the most significant factor contributing to the severity of the 2002.
- In all the drought-affected areas, there has been a time delay in farming activities and harvest establishment.
- Due to the occurrence of drought in a linear direction, there is a weakening and distribution of the established crop.
- Crops are more susceptible to insects, pests, and diseases during the growing season than they are during normal seasons.
- It is obvious that the physiological and biochemical metabolism of food grain plants has been altered during the drought season.
- Farm products such as food grains, fodder, fibre, and oilseed crops have suffered from a decline in quality.
- In both rainfed and irrigated areas, crop yields have suffered a significant reduction.
- Droughts not only reduce the overall crop production during the affected year, but they also have a negative impact on the country's GDP and economic growth.

Droughts have had a variety of effects in India, which can be summarised under the following headings:

i. Physical Impact:

Dried soil moisture recharge, storm water, and the groundwater level are all negatively impacted by droughts caused by weather conditions. Landslides cause soils to dry out, surface runoff to decrease, and the amount of ground water to decrease. Wells and tube-wells are left unused because of the declines of the groundwater level caused by the running dry of ponds, rivers, ponds, and reservoirs, which causes the ground water table to drop.

ii. Impact on Agriculture

Indian farming remains largely dependent on monsoon rainfalls, with about two thirds of the nation's agricultural land not being irrigated and so referred to as rainfed. Drought years are characterised by a decrease in agricultural production because of this phenomenon. There are numerous examples throughout history of significant reductions in cultivated land and decreases in agricultural productivity.

A severe shortage of food grains had been observed, and the country was forced to rely on the importation of food grains to keep the poor people from starving to death. Despite this, India has been able to develop a buffer stock of food–grains, and the danger of drought conditions is no matter how long as severe as it was prior to India's adoption of the Green Revolution in the 1970s.

While meteorological drought conditions may have reduced farm production, hydrological and agroforestry droughts have had a lengthy and broad-based impact on the farming industry. Depending on where you live, this impact could result in formation of cropping patterns shifting or cattle becoming malnourished.

iii. Social and Economic Impact:

The social and economic consequences of a drought are far more severe than the physical and agricultural consequences of a drought. Drought is almost always associated with famine, which has its own set of social and economic ramifications in the affected area.

5. Impact of Drought in Maharashtra

Maharashtra state is in the western and central regions of India, with a geographical area of 3, 07, 713 square kilometres. Its borders are defined by latitudes 150 40' and 220 00' N and longitudes 720 30' and 800 30' E. Maharashtra is the state with the largest population in India. The state has a coastline that stretches for 720 kilometres along the Arabian Sea. Karnataka, Madhya Pradesh, Goa, Gujrat, and Telangana are the states that share a border with the state. If we look at the state from a physiographic standpoint, we can divide it into three parts: coastal Konkan, western Sahyadri, and the Deccan plateau. A monsoon climate prevails in the state from June to September. Physic-geographic divisions affect the distribution of rainfall, with some areas having a much more uneven distribution than others. The Konkan region receives heavy rainfall (>2000 mm), while the Deccan Plateau and Western Ghat obtain medium rainfall (1000 mm) (Avg. 600-1000 mm). During the winter and summer seasons, the temperature ranges from 12 to 450 degrees Celsius, respectively. The regions of Vidarbha, Marathwada, and Khandesh are experiencing an extremely hot summer. Most of the state's agricultural land is irrigated by major rivers such as the Godavari, Krishna, Koyana, Tapi, Bhima, Narmada, Wardha, and Wainganga, as well as smaller streams. Peninsular shield geological formations composed of ancient rocks from the Precambrian, Proterozoic, and Perm carboniferous periods are found in a portion of the peninsular shield. Most of the basalt in the Deccan trap covers 80 percent of the state's land area. A lack of water percolation is caused by basalt's low permeability, causing water shortages and drought-prone circumstances in many areas of the state. Only the Vidarbha and Konkan regions contain 90 percent of the world's economic minerals, which include coal, iron, manganese, limestone, bauxite, and other minerals.

State of Maharashtra in India is a highly developed and industrialized region. It is the third most populous state in the world, with a geographical area of 307713 sq km and a population of 112.3 million people. The cultivable land area is 2.25 lakh Sq Km, with 17.6 percent of the land area covered by forest. Agriculture and related activities provide a source of income for approximately 55 percent of the population. Maharashtra is made up of 36 districts, each with six administrative divisions: Konkan (Mumbai), Nagpur, Amravati, Aurangabad, and Nashik (in the north). Surface water resources account for 164 km3 of annual available water resources, with subsurface water resources accounting for 20.5 km3. For the state of Maharashtra, drought is one of the most severe natural disasters, posing a significant threat to the state's economy as well as agricultural development. Because of this, managing the drought has become a major concern, and successfully coping with it requires significant scheduling of water resources and natural production. When comparing rural and urban areas, the severity of drought's effects is most noticeable in rural settings. Farmers, labourers, and livestock are among the most vulnerable groups during a drought. Droughts have direct consequences for agricultural yields and industrial production, both of which are reduced.

Agriculture drought leads to famine, which in turn leads to a drought situation. Acute water and food shortages are a result of environmental degradation, which has caused distress in the affected communities. Land degradation and a decrease in livestock population are also consequences of the situation, which disrupts the ecosystem's energy cycle.

The hydrological drought is followed by the agricultural drought, which in turn leads to the socioeconomic dry spell. The lack of rainfall in the years 2013 and 2015 had a negative impact on the overall agricultural yield in the state of Maharashtra. The average rainfall in the years 2013–2014 has resulted in an increase in agricultural yields. It is estimated that the yield has decreased by a significant amount in the year 2014-2015, with a 50 percent deficit in pulse, oilseed, and cotton production compared to the previous year 2013-2014. The primary reason for this decrease is a lack of rainfall in 2014-2015.

In Maharashtra, an agricultural crisis has created a series of suicides, which became increasingly common. Except for 2013, the number of farmers attempting suicide has increased from 1495 (2011) to 2016 (2015). Impact of Drought on Environmental, Agricultural, and Socioeconomic Status in Maharashtra State, India. Because of abundant rainfall and high agricultural yields in 2013, the number of suicides decreased to 1298, ultimately saving the lives of those who attempted suicide. Suicide rates in the cotton belt in the Aurangabad division are higher than the national average because of rising costs of cultivation, indebtedness, crop failure, and bottlenecks in the agricultural marketing system, the study concludes (in Hindi).

Groundwater depletion is a result of the state's persistent drought-prone condition, which affects many parts of the state. Bore wells are being used to collect water from wells that are more than 600 metres deep, and the number of bore wells is increasing at the same time. Because of the rapid rate at which water is being discovered, our generation will face a water scarcity in the not-too-distant future. Desertification occurs because of severe drought over an extended period. This process has an impact on the human societies' ability to exert pressure on the dry and fragile ecosystem. At its most extreme, it could increase malnutrition and demise, as well as economic collapse and social disintegration. The ecosystem is out of balance, and the consequences of this will be felt for a long period of time to come.

6. Future action plans for managing droughts

To plan for future drought mitigation, it is necessary to create a databank that contains historical scenarios of major drought. Because the Central Government has already established permanent procedures for the Calamity Relief Fund, the intensity and impact of drought are expected to be less severe and devastating. Many sponsored programmes include the Drought Prone Area Program (DPAP), the Rural Works Program (RWP), the Food for Work Program (FWP), the Desert Development Program (DDP), and others. Some of the sponsored programmes include the Drought Prone Area Program (DPAP), the Rural Works Program (RWP), the Desert Development Program (DDP), and the Desert Development Program (DDP). The Rural Works Program (RWP), the Desert Development Program, the Drought Prone Area Program (DPAP), and the Food for Work Program are just a few of the government-sponsored initiatives (FWP). Additionally, the Crop–Weather Watch Group and the Technology Mission have already been established to combat the droughts in addition to these relief programmes. Crop insurance schemes for rice, wheat, millets, oilseeds, and pulses are being implemented to provide a sustainable way of life for those who are subjected to frequent droughts. The development of dryland areas (primarily those that are prone to drought) is also a national obligation because they are home to some of India's most marginalized and impoverished people, who must be assisted. An effort will be made to achieve a few of the Millennium Development Goals to lift them out of poverty, hunger, and malnutrition, among other things (MDG). These areas are also rich in agro-biodiversity, and they contain valuable genes that will be required to cope with the adverse effects of predicted global climate change in the coming decades. As a result, an action plan is essential, which is highlighted as follows:

- To ensure reliable monsoon predictions and proper agro–meteorological analysis of the climate–soil–crop relationship, efforts should be made in the areas of crop planning and management.
- Plant improvement (field crops and horticultural crops) should be done in relation to the lowest possible water requirement as well as to suit the diverse ecological conditions of different regions.
- The funds available for catchment treatment options are insufficient and should be increased.
- Make certain that every new water source is equipped with a recharge system.
- The government should consider providing subsidies to irrigated marginal farmers in exchange for their decision not to sow paddy in the long term (it will save the irrigation water).
- Emergency relief funds should be channeled through the Gram Sabha in cases of crisis. Farmers who are experiencing increased costs of production during the drought season, as well as farmers who are losing animals because of the drought, should receive some monetary assistance. Compensation for areas that have been left uncultivated because of the drought should be made available.
- Each village should have a century–well, which should be drilled. This well should only be used in drought years to make efficient use of groundwater and to avoid moisture–stress situations in the surrounding area.
- It is recommended that community seed banks be established for the rainy seasons that are prone to drought.
- To save animals in severe drought conditions, the community should work together to develop pastures and grazing areas, as well as to supply Urea–Molasses–Mineral fodder packs.

- Completed irrigation projects and the reclamation of waterlogged areas are two priorities. By 2030, it is anticipated that 69 million hectares (ha) will be covered by micro–irrigation.
- Diversification of cropping systems (including agroforestry and horticulture) to conserve water and improve water management efficiency. Encourage the use of drought-tolerant crops and cultivars in agricultural production.
- Increasing the popularity of resource-conservation technologies and conservation agriculture practices on a broad scale may be beneficial in improving resource use efficiency and crop productivity in drought-prone areas. As a bonus, these technologies can also aid in the mitigation of the consequences of drought and climate change.
- Modified sowing methods such as aqua-fertilizer drills, zero-tillage drills, and the FIRB system should be used to improve crop stand, reduce energy consumption, and increase the efficiency with which water and fertiliser are used.
- To keep track of irrigation water losses, laser levelling of fields is performed. Water should be used in conjunction with other resources to ensure proper water management.
- To improve farming in dryland areas, on-farm rainwater harvesting and efficient utilisation, as well as on-farm production of organic matter, should be implemented. Adoption of appropriate agronomic practices for the conservation and utilisation of moisture under rainfed conditions is essential.
- Improvements in contingent crop planning for major aberrant weather conditions, with a particular emphasis on mitigating the effects of drought.
- To restore ecological balance, planting trees and developing silvic–pastoral and horticultural systems are required. Additionally, livestock must be developed to generate rural employment.
- It is necessary to strengthen the National Watershed Development Program for rainfed agricultural production.
- To begin, there are methods of storing runoff from rainy periods to use it during periods of prolonged drought. Tanks, ponds, and earth dams used for supplementary irrigation are examples of such structures.
- Creating Weather Insurance products that are tailored to specific regions and crops.

7. Conclusion

Due to the wide availability of fresh water used for agricultural domestic, and industrial purposes in barrages. As the intensity of drought increases, it affects the farming sector and the state economy directly. People from drought areas affected have begun migration to urban areas in other areas for employment. Drought disrupts agricultural output, and the balance between agricultural production supply and demand will be disrupted and inflation ultimately increases. Agricultural cereal, pulse and cotton production was reduced in 2015 to 50 percent compared to the previous year. The drought seriously impacted Maharashtra cotton belt, where the greatest proportion of suicidal farmers were reported in 2015. In the Aurangabad division, the farmers are transferred to cash crops, i.e., sugar cans, bananas, and turmeric, which require more water than cereal crops and pulse crops.

The watershed growth will increase surface water and groundwater resources. The management of drought should take place through public involvement and awareness to cope with future droughts. Scientific improvement will play a key role in balancing the ecosystem in the breeding of more drought-resistant animals and plant species. Water budgeting is also very important at all levels.

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