

## Chapter 16

### Drought disaster in India, mitigation and their impacts

### Desastre de sequía en India, mitigación y sus efectos

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#### ABSTRACT

Drought is a natural disaster. When there is a crack in the land due to a lack of rain in a place for a long time, it is called drought due to lack of water. The main causes of drought in India are natural, altered-weather patterns, excess water demands, deforestation, soil degradation, global warming, and climate change. There are types of drought agricultural, meteorological, and hydrological drought. The states affected by drought in India are Gujarat, Jammu and Kashmir, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Haryana, Odisha, Chhattisgarh, Madhya Pradesh, Bihar, West Bengal, Jharkhand, Tamil Nadu, and Uttar Pradesh. Drought has an environmental, social, and economic impact. In this review, a detailed discussion of the cause of drought, loss, area, mitigation, etc. has been given.

*KEYWORDS: Drought, causes, history, impacts, management, mitigation, and (NIDM).*

#### RESUMEN

La sequía es un desastre natural. Cuando hay una grieta en la tierra por falta de lluvia por mucho tiempo en un lugar, se le llama sequía por falta de agua. Las principales causas de la sequía en la India son los patrones climáticos cambiantes naturales, la alta demanda de agua, la deforestación, la erosión del suelo, el calentamiento global y el cambio climático. Las sequías son tipos de sequías agrícolas, meteorológicas e hidrológicas. Los estados afectados por la sequía en India son Gujarat, Jammu y Cachemira, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Haryana, Odisha, Chhattisgarh, Madhya Pradesh, Bihar, Bengala Occidental, Jharkhand, Tamil Nadu y Uttar Pradesh. La sequía tiene efectos ambientales, sociales y económicos. En esta revisión, se ha dado una discusión detallada de las causas, pérdidas, área, mitigación, etc.

*PALABRAS CLAVE: Sequía, causas, historia, efectos, manejo, mitigación y (NIDM).*

## INTRODUCTION

Drought is a complex hydrologic phenomenon related to climate, water, and land use [1, 2]. A drought is an event of long-lasting water shortages, whether atmospheric (lower than average rainfall), surface water, or groundwater. A drought can last for months or years or occur after 15 days [3]. It can have a significant impact on the ecosystem and agriculture of the affected region [4], and harm the local economy [5]. Annual dry seasons in the tropics greatly increase the likelihood of drought and subsequent wildfires. Heat waves can significantly worsen drought conditions by accelerating the evaporation of water vapor [6]. Drought is considered a recurrent feature of the climate in most parts of the world. Today's regular drought has become more extreme and unpredictable due to climate change. Studies based on dendrochronology also confirm that global warming affected by drought dates back to 1900 [7]. The effects of this phenomenon can be based on the use of water in some agricultural or industrial districts, cities, towns, villages or the whole country, such as for irrigation, drinking water, hydropower, industrial usage, recreation, wildlife, etc. Drought, a serious and continuing problem all around the world, is an ordinary hydrologic phenomenon and is generally caused by a lack of planning and management. There is no region immunized to drought, as well as to flooding. Dealing with drought must be a process, not a project that starts and finishes with drought [1, 2]. India is a voluntary signatory of the Sendai Framework for Disaster Risk Reduction<sup>28</sup>. It also aims to timely achieve a few sustainable development goals of the United Nations i.e., no poverty, zero hunger, good health & well-being, and reduced inequality. For this, it is necessary that at the national as well as the sub-national (state) level, the policies towards disaster management should be appropriate and effective. Among all natural disasters, drought is a common and common type in India, causing major agricultural and economic losses. The existing literature suggests that the drought definition, management, and subsequently, drought relief practices significantly vary at the sub-national level in India [8].



Figure: 1 Maharashtra govt. declares drought in 151 Tehsils

Source: <https://timesofindia.indiatimes.com/city/mumbai/maharashtra-govt-declares-drought-in-151-tehsils/articleshow/66448739.cms>

## CAUSES OF DROUGHT

**Natural Causes:** Some droughts have occurred naturally and have plagued mankind for much of our history. Until recently, natural droughts were often natural phenomena triggered by cyclic weather patterns, such as B. the amount of moisture and heat in the air, on land, and in the sea [10].

**Altered weather patterns:** The global precipitation pattern can also be affected by the way air moves through the atmosphere. When there is an anomaly in surface temperatures, especially over the sea, air circulation patterns are altered. This changes how and where precipitation falls around the world, and the new weather patterns will most likely imbalance water supply and demand, as is the case when snowmelt earlier than usual reduces the amount of water needed for summer crops [10].

**Excess water demands:** Droughts can also result from an imbalance between water supply and demand. As the world's population continues to grow and intensive agricultural practices continue, more water will be needed to sustain the human race and agricultural practices. This continues to tip the balance and make drought a daily reality. A study estimated that human water use increased the frequency of droughts in North America by 25% between 1960 and 2010. The situation is exacerbated by the decrease in precipitation, forcing people to pump more water into rivers, aquifers, and reservoirs. This depletes valuable water resources, which take years to replenish, and can permanently affect future water availability. At the same time, the demand for water supplied by lakes and rivers upstream, particularly in the form of irrigation and hydroelectric dams, is leading to the decline or drying up of watersources downstream, further contributing to drought in other regions [10].

**Deforestation and soil degradation:** Trees and plants are important because they release moisture into the atmosphere, causing clouds and precipitation, which return moisture to the soil. Unfortunately, humanity is the best at destroying these natural resources. As forests and vegetation disappear, less water is available to feed the water cycle, making entire regions more vulnerable to drought. Meanwhile, deforestation and other land misuse practices, such as intensive agriculture, continue to reduce soil quality and the ability of the soil to absorb and retain water. As a result, the soil dries out faster, leading to agricultural drought and less groundwater supply, contributing to hydrological drought [10].

**Global warming:** As the name suggests, the planet is warming at an alarming rate, which can lead to drought. Global warming is usually associated with human activity, such as the release of greenhouse gases that create a trapping effect, increasing global temperatures. With higher temperatures, water from rivers, streams, lakes, and other bodies of water will continue to evaporate and other practices will result in less water fall in the form of rain. This will therefore lead to less rainfall and, of course, drought [10].

Climate change: Rising temperatures are making wetlands more humid and dry areas drier. For wetter regions, warm air will absorb more water, leading to more precipitation, while in drier regions, warmer temperatures mean the water evaporates faster. Climate change is also changing large-scale atmospheric circulation patterns, shifting storm tracks from their typical paths. This in turn amplifies extreme weather conditions, which is why climate models predict that the already arid US southwest and the Mediterranean will continue to get drier [10].

### 1. Meteorological drought

It is a situation where rainfall falls below a certain amount over a period of time, meaning the actual rainfall in an area is significantly less than the climatic average of that area. According to the Indian Meteorological Department (IMD), drought occurs when the average annual rainfall is less than 75% of normal. IMD also stated that rather than the total amount of rainfall, its uniformity is more important. We can observe that although India receives an average annual rainfall of 110 cm, the uniformity of rainfall, due to the irregular and concentrated nature of rainfall, there are frequent droughts [11].

### 2. Hydrological drought

It is associated with the reduction of the water level. There are 2 types of hydrological droughts

- Surface Water Drought – Affects the drying up of surface water resources such as rivers, streams, lakes, ponds, reservoirs, etc.
- Drought of water tables – This is associated with a drop in the water table [11].

### 3. Agricultural drought

It occurs when soil moisture drops below the level needed to support plant growth. It is also called soil moisture drought. Irregular rainfall and insufficient soil moisture lead to crop failure [11].

#### Geographical Spread of Drought

Large parts of the country perennially reel under recurring drought; over 68%-70% of India is vulnerable to drought. As mentioned earlier, 33%, classified as “chronically drought-prone areas” receive less than 750 mm of rainfall, while 35%, classified as “drought-prone areas” receive rainfall of 750-1125 mm. The drought-prone areas of the country are confined to peninsular and western India primarily arid, semi-arid, and sub-humid regions [13].

Table 1: Cropped Area Falling Under Various Ranges of Rainfall in India

No.	Rainfall Ranges	Classification	%
1	Less than 750 mm	Low rainfall	33 %
2	750 mm to 1125 mm	Medium rainfall	35%
3	1126 mm to 2000 mm	High rainfall	24%
4	Above 2000 mm	Very high rainfall	8%

Source: Drought 2002, a Report, Ministry of Agriculture, Government of India

#### METEOROLOGICAL HISTORY OF DROUGHTS IN INDIA

Between 1871 and 2002, there were 22 major drought years, defined as years with All India Summer Monsoon Rainfall (AISMR) less than one standard deviation below average (i.e. i.e. below -10% anomaly): 1873, 1877, 1899, 1901, 1904, 1905, 1911, 1918, 1920, 1941, 1951, 1965, 1966, 1968, 1972, 1974, 1989, 1989, 1989 , 1985 , 1986 , 1987 , 2002. The frequency of droughts has changed over the decades. From 1899 to 1920, there were seven years of drought. The incidence of droughts decreased between 1941 and 1965 when the country experienced only three years of drought [12, 13]. Also between 1965 and 1987, 10 of the 21 years were drought years, and the increased frequency was attributed to the El Niño Southern Oscillation (ENSO). Among drought years, the 1987 drought was one of the worst droughts of the century, with an overall rainfall deficit of 19%. It affected 59 to 60% of the cultivated area and a population of 285 million. Also in 2002, the national rainfall deficit was 19%. More than 300 million people in 18 states have been affected to varying degrees by the drought. About 150 million cattle have been affected due to a lack of feed and water. Production of food grains saw the largest drop of 29 million tonnes. No other drought in the past has led to such a decline in foodgrain production [12, 13].

Table 2: Administrative Districts Chronically affected by Drought Conditions

State	Districts
Gujarat	Jamnagar, Mehsana, Panchmahal, Rajkot, Ahmedabad, Surendranagar, Amreli, Banaskantha, Kheda, Kutch, Bhavnagar, Bharuch
Jammu and Kashmir	Udhampur, Doda
Rajasthan	Jaisalmer, Jalore, Nagaur, Pali, Barmer, Udaipur, Churu, Jhunjunu, Jodhpur, Dungarpur, Ajmer, Banswada
Maharashtra	Beed, Aurangabad, Nanded, Nashik, Sangli, Parbhani, Satara, Solapur, Ahmednagar, Osmanabad, Pune
Andhra Pradesh	Mehboobnagar, Hyderabad, Anantpur, Chittoor, Cuddapah, Kurnool, Nalgonda, Prakasam
Karnataka	Chickmagalur, Bangalore, Dharwad, Gulbarga, Belgaum, Hassan, Kolar, Bijapur, Chitradurga, Mandya, Bellary, Mysore, Raichur,

	Tumkur
Haryana	Gurgaon, Rohtak, Mahendranagar, Bhiwani
Odisha	Phulbani, Kalahandi, Bolangir, Kendrapada
Chhattisgarh	Khargaon
Madhya Pradesh	hahjapur, Sidhi, Ujjain, Betul, Dhar, Jhabua, Datia, Khandak, Dewas, Shahdol, Shahjapur
Bihar	Munger, Nawadah, Rohtas, Bhojpur, Aurangabad, Gaya
West Bengal	Midnapore, Bankura, Purulia
Jharkhand	Palamau
Tamil Nadu	Tiruchirapali, Dharmapuri, Ramanathapuram, Madurai, Salem, Coimbatore, Tirunelveli, Kanyakumari
Uttar Pradesh	Hamirpur, Allahabad, Jalana, Mirzapur, Banda, Varanasi

Source: [Department of Agriculture and Cooperation]

In India, drought-prone areas cover a total area of 329 million hectares, three-quarters of which are arid, semi-arid, and sub-humid areas.

- Dry zone (19.6%): Average annual precipitation (MAP) of 100 to 400 mm (lack of water all year round); Rajasthan, parts of Haryana, and Gujarat. Droughts are severe in this area.
- Semi-arid zone (37.0%): MAP of 400-600 mm (excess of water in certain months and deficit in other months); Parts of Haryana, Punjab, Western Uttar Pradesh, Western Madhya Pradesh, and also most parts of Western Ghats Peninsula. Drought can be moderate to severe in this area.
- Arid sub-humid zone (21.0%): MAP of 600-900 mm in India; Parts of the northern plains, central highlands, eastern plateau, parts of the Eastern Ghats and plains, and parts of the western Himalayas. Droughts are moderate in this area.
- Wet and humid regions such as Assam and other northeastern states rarely experience drought [12].

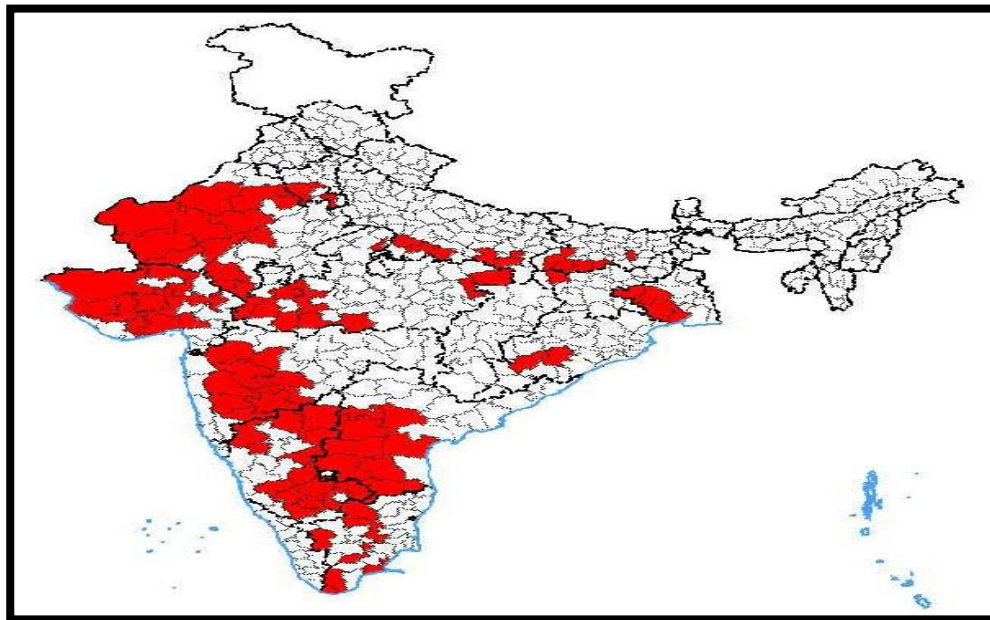


Figure: 2 Map of drought prone districts of India (Drought prone areas are in red). [Stephen, A., 2012].

#### THE IMPACTS OF DROUGHTS

Drought has considerable effects on all sectors of the economy. The impacts are felt by the economy far beyond sectors as agricultural production and water resources are integral to the production of goods and services [15].

**Economic impacts:** Refer to production losses in agriculture and related sectors, especially forestry and fisheries, as these sectors depend on surface and groundwater supplies. It leads to a loss of income and purchasing power, especially for farmers and the rural population dependent on agriculture. All industries that depend on the primary sector for their raw materials would suffer losses due to reduced supply or higher prices. The drought, therefore, has a multiplier effect across the economy, dampening employment, credit flow, and tax collection. If the drought is at the national level, macroeconomic indicators at the national level are negatively affected [12].

**Environmental impacts:** Such as lowering the water level in reservoirs, lakes, and ponds, as well as reducing flows from springs and streams, would reduce the availability of feed and drinking water and negatively impact fish and wildlife habitats. It can also lead to loss of forest cover, wildlife migration, and increased mortality due to increased contact with agricultural producers, as animals forage on farms and producers are less tolerant of intrusions. Prolonged drought can also lead to increased stress on endangered species and loss of biodiversity. The reduced flow of the stream and the loss of wetlands can cause changes in salinity. Increased groundwater depletion, subsidence, and reduced replenishment can damage groundwater and adversely affect water quality (e.g. salt concentration, water temperature rise, acidity, dissolved oxygen, turbidity). Deterioration of landscape quality, including increased soil erosion, can lead to a more permanent loss of the biological productivity of the landscape [12].

**Social impacts:** Derive from a lack of income that pushes populations out of areas affected by drought. People in India are trying to cope with drought in several ways that affect their sense of well-being: they take their children out of school, postpone their daughters' marriages, and sell their goods such as land or livestock. In addition to economic hardship, it also causes a loss of social status and dignity, which people find difficult to accept. Inadequate food intake can lead to malnutrition and in some extreme cases, hunger. Access to and use of scarce water resources lead to conflict situations that can be socially disruptive. Inequality in the distribution of drought impacts and relief efforts can further exacerbate these social tensions [12].

#### PREVENTIVE MEASURES TO TAKE IN THE DROUGHT PRONE REGIONS IN INDIA

These are some solutions to reduce the risk of famine in India's major drought-prone areas.

- Good water management and storage in dams/basins

- Management of river basins and monitoring of water rationing
- Livestock management
- Select the right crop that needs less water in drought-prone areas
- Implementation of soil-saving techniques
- Reforestation and reduction of the use of firewood
- Use alternative terrain models to save water
- Reduce migration and provide employment
- Training of people on water conservation
- Modification of cultivation patterns and selection of drought tolerant crop varieties
- Apply better grazing models
- Plant more shrubs and trees
- Protection of surface waters by introducing a drip irrigation system
- Use of new technologies for farming activities [16].

In addition to these preventive measures, individuals must also financially secure themselves to face the calamity with confidence. A smart solution might be to opt for life insurance or drought insurance to secure their family's future. Individuals can also insure their expensive assets and get the right returns in the face of such disasters [16].

#### DROUGHT MITIGATION SYSTEM

Although some scientists have the opinion that “you cannot manage drought” (Higginson, 1994), since, drought mitigation is often really just a survival strategy and surviving is depending on grazing management, stock reduction strategy, financial plans, as well as vegetation recovery plans when droughts end, we can constitute an effective organized management strategy. Drought management includes not only organizing all water control facilities but also planning, designing, application, and organizing. Fighting drought is not easy generally that politicians and society may not understand the importance of the event, there may not be a drought management plan, there may be a financial insufficiency, there may be subject to any kind of drought types together and responsibilities may be divided among many governmental jurisdictions (NDMC, 2004) [2].

Drought managers can reduce the damage and cost of drought by applying effective drought management approaches. For this purpose, Managers generally use the following devices f

- Risk-based planning, and examining f
- To get acquired social conscious, f
- Source management f t
- Take legal measurements (maybe to diversify prices) f
- To train society (may be in water usage, irrigation or planting techniques, or in disaster management) f
- Economic regulations for water usage [2].



THE NDMA GUIDELINES ON THE MANAGEMENT OF DROUGHT ARE ISSUED IN 2010. THE RECOMMENDATIONS ARE  
AS FOLLOWS:

1. Establishment of Drought Monitoring Cells (DMC) at the state level with necessary staff.
2. Creation of vulnerability maps for each state by the state DMCs.
3. Development of real-time drought information through the use of information and communication technologies.
4. The watershed development approach would be adopted for drought management.
5. Integration of ground information with spatial information for comprehensive reporting.
6. Damage assessment includes agricultural production, water depletion, livestock, soil degradation, deforestation, as well as human health.
7. Renewal of the Drought Management Information System of the Ministry of Agriculture.
8. To enable micro-level analyzes and forecasts, automatic weather stations and rain gauges must be installed.
9. Development of drought tolerant crop varieties through large-scale research.
10. Mitigation measures to be taken include cloud seeding and conducting pilot studies in all categories of drought-prone areas to propose long-term mitigation measures.
11. Formulate a cloud seed policy.
12. Encourage crop diversification through sprinkler/drip irrigation systems (micro-irrigation techniques).
13. Quick loan in areas affected by drought; and expand marketing and pricing support.
14. A sub-label forest, seamaruba, casuarinas, eucalyptus, and biodiesel plantations such as Jatropha and Pongamia.
15. Development of insurance products for different agro-climatic zones that offer coverage against drought. Extension of crop insurance to post-harvest losses. Promotion of insurance products at controlled prices to avoid clearance sales of agricultural products. Using satellite imagery of crop conditions as a substitute for crop yield estimates to settle insurance claims.
16. Design a realistic national training and capacity-building program for drought management. PRI and ULB agents must be trained accordingly.
17. Encourage NGOs, PRIs, and ULBs to sensitize farmers.
18. Update university and undergraduate agricultural curricula to include drought management.
19. Fodder, fodder, and mineral mixtures supplied to all farm animals to prevent scavenging of livestock.
20. Whenever necessary and feasible, CSR should also involve the business sector in supporting drought risk management efforts [17].

#### NATIONAL INSTITUTE OF DISASTER MANAGEMENT (NIDM)

Under the provisions of Chapter VII of the DM Act, the Government of India has established the National Institute of Disaster Management (NIDM) under an Act of Parliament as the lead institute for disaster management capacity development. disasters in India and the region. The vision of NIDM is to create a disaster-resilient India by building capacity for disaster prevention and preparedness at all levels [18]. NIDM has been entrusted with key responsibilities in human resource development, capacity building, training, research, documentation, and policy advocacy in the field of disaster management. NIDM has established strategic partnerships with various departments and departments of central, state, and local governments, academic, research, and technical organizations in India and abroad, and other bilateral and multilateral international organizations. It provides technical support to state governments through the Disaster Management Centers (DMCs) of the State and Union Territory (ATI) Administrative Training Institutes. It currently supports up to 30 of these centers. Six of these are being developed as centers of excellence in specialized areas of risk management: floods, earthquakes, cyclones, droughts, landslides, and industrial disasters [18].

#### CONCLUSION

Drought is a natural disaster. When there is a crack in the land due to a lack of rain for a long time at a place, it is called drought due to lack of water. The drought-affected states in India are Gujarat, Jammu and Kashmir, Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Haryana, Odisha, Chhattisgarh, Madhya Pradesh, Bihar, West Bengal, Jharkhand, Tamil Nadu, and Uttar Pradesh. Drought has environmental, social, and economic effects. The government should provide proper employment opportunities in drought-affected areas. Appropriate steps should be taken to conserve water in drought-affected areas. An awareness campaign should be started for water conservation.

#### REFERENCES

1. Grigg, N. S. , 1996, "Water Resources Management", McGraw-Hill, Dept. of Civil Engineering, Colorado State University, Colorado, ISBN 0-07024782-x.
2. Baykan, N. O., & Özçelik, C. (2006). Management of drought. *Water resources management: Risks and Challenges for the 21st century, Turkey*, 55-62.
3. It's a scorcher - and Ireland is officially 'in drought' Irish Independent, 2013-07-18.
4. Living With Drought Archived 2007-02-18 at the Wayback Machine
5. Australian Drought and Climate Change Archived 2018-07-26 at the Wayback Machine, retrieved on June 7th 2007.
6. <https://en.wikipedia.org/wiki/Drought>
7. <https://www.toppr.com/guides/chemistry/environmental-chemistry/droughts/>

8. Ashish, S. (2019). Drought management policy of india: An overview. *Disaster Adv [Internet]*, 12(11), 51-62.
9. <https://timesofindia.indiatimes.com/city/mumbai/maharashtra-govt-declares-drought-in-151-tehsils/articleshow/66448739.cms>
10. <https://www.conserve-energy-future.com/causes-effects-solutions-drought.php>
11. <https://lotusarise.com/drought-upsc-notes/>
12. Manual for Drought Management. Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, (2009), <https://agricoop.nic.in/sites/default/files/DroughtManual.pdf>
13. Sharma, B. R., & Smakhtin, V. U. (2006). Potential of water harvesting as a strategic tool for drought mitigation. *International Water Management Institute (IWMI)*.
14. Stephen, A. (2012). Natural disasters in India with special reference to Tamil Nadu. *J Acad Indus Res*, 1, 2278-521.
15. <https://www.iasexpress.net/drought-india-management/>
16. <https://www.godigit.com/guides/natural-disasters/drought-prone-areas-in-india>
17. <https://samajho.com/upsc/ndma-guidelines-on-drought-management/>
18. National Disaster Management Plan May 2016, <https://www.mha.gov.in/sites/default/files/National%20Disaster%20Management%20Plan%20May%202016.pdf>

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