DROUGHT (INDIA)

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INDIA METEOROLOGICAL DEPARTMENT

WATER AVAILIBILITY IN INDIA

AREA OF THE COUNTRY	32,87,263 SQ. KMs
RAINFALL	4000 KM^3
SURFACE WATER POTENTIAL	684 KM^3
GROUND WATER POTENTIAL	423 KM^3
Total	1107 KM^3

RAINFALL IN INDIA

- **RAINFALL : 117 cms (ANNUAL), 90 CMS (SW Monsoon)**

- **HIGHLY VARIABLE IN SPACE**

  15% AREA OF INDIA > 150 CMS
  64 % AREA OF INDIA 75 – 150 CMS
  15% AREA OF INDIA 40 – 75 CMS
  6% AREA OF INDIA < 40CMS

- **HIGHLY VARIABLE IN TIME**

  76 % OF ANNUAL RAINFALL OCCURES DURING 4 MONTHS.

DROUGHT

- DROUGHT IS A SITUATION OF SIGNIFICANT WATER SHORTAGE
- DROUGHT MAY BE DUE YO INSUFFICIENT RAINFALL OR INCREASE IN WATER DEMAND
- DROUGHT EFFECTS POPULATION SPREAD OVER LARGER AREAS AND LONGER PERIOD OF TIME

TYPES OF DROUGHT

METEOROLOGICAL

WHEN ACTUAL RAINFALL OVER AN AREA IS LESS THAN THREE FOURTH OF THE NORMAL VALUE I.E., THE LONG-TERM CLIMATOLOGICAL MEAN.

HYDROLOGICAL

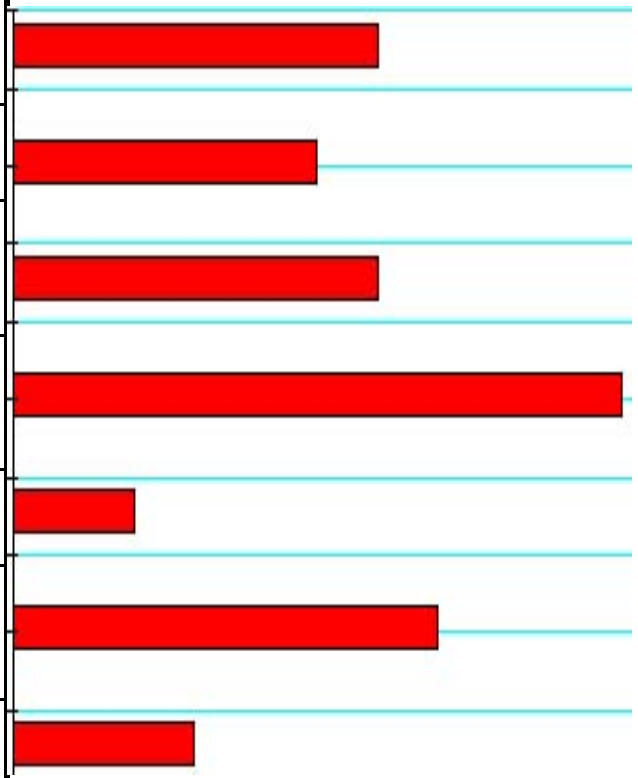
WHEN THERE IS MARKED DEPLETION OF SURFACE WATER CAUSING VERY LOW STREAM FLOW AND DRYING OF LAKES, RESERVOIRS AND RIVERS. IT MAY ALSO RESULT IN RECESSION OF SPRING FLOWS AND GLACIERS DUE TO INSUFFICIENT REGENERATION OF SEASONAL SNOW COVER.

AGRICULTURAL

WHEN SOIL MOISTURE IS INADEQUATE TO SUPPORT HEALTHY GROWTH OF CROPS RESULTING IN VERY LOW YIELD. WATER LEVEL GOES LOWER (DEEPER) AND GROUND WATER IS UNABLE TO MEET THE NEEDS.

HISTORY OF DROUGHTS IN INDIA

PERIOD	DROUGHT YEARS	NUMBER OF DROUGHT
1801-1830	1801, 1804, 1806, 1812, 1819, 1825	6
1831-1860	1832, 1833, 1837, 1853, 1860	5
1861-1890	1862, 1866, 1868, 1873, 1877, 1883	6
1891-1920	1891, 1897, 1899, 1901, 1904, 1905, 1907, 1911, 1918, 1920	10
1921-1950	1939, 1941	2
1951-1980	1951, 1965, 1966, 1971, 1972, 1974, 1979	7
1981-2010	1982, 1987, 2002, 2009	4



EARLY WARNING INDICATORS

- **DEFICIT RAINFALL**
- **FALL IN GROUND WATER LEVEL**
- **DROUGHT INDICES**
  - **ARIDITY ANOMALY INDEX**
  - ***PALMER DROUGHT SEVERITY INDEX (PDSI)***
  - ***SURFACE WATER SUPPLY INDEX (SWSI)***
  - ***CROP MOISTURE INDEX (CMI)***
  - ***STANDARDIZED PRECIPITATION INDEX (SPI)***

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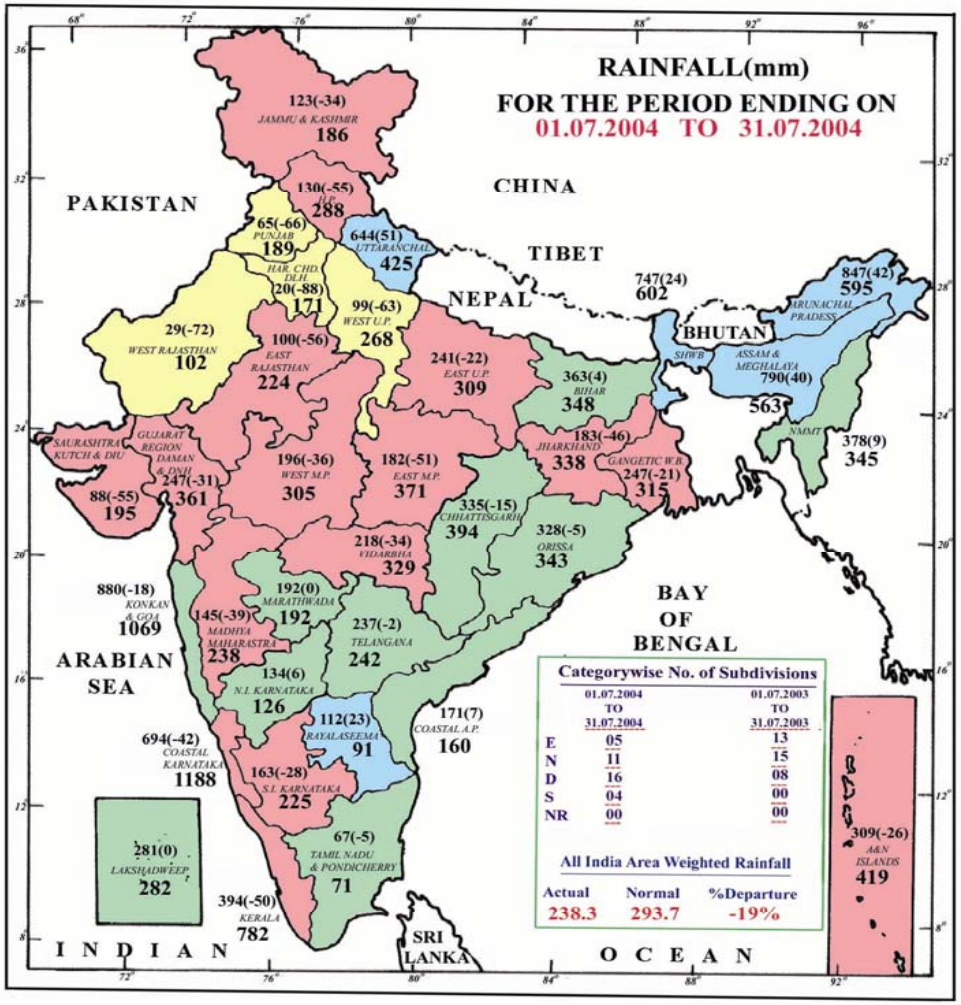


LEGEND : EXCESS (E) + 20% OR MORE | NORMAL (N) +19% TO -19% | DEFICIENT (D) -20% TO -59%

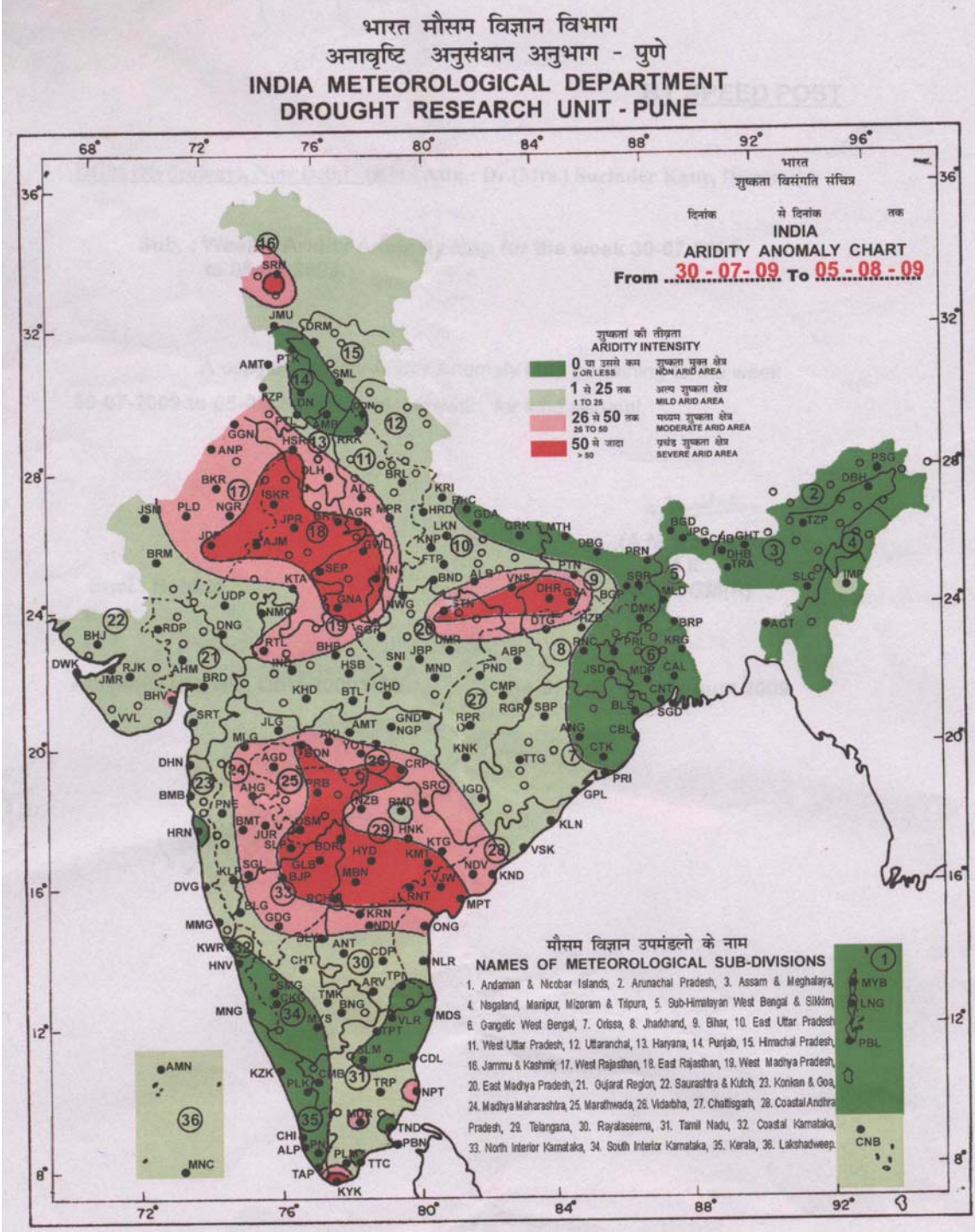
SCANTY (S) -60% TO -99% | NO RAIN (NR) -100% | NO DATA

NOTES:

(a) Rainfall figures are based on operational data.

(b) Small figures indicate actual rainfall (mm), while bold figures indicate normal rainfall (mm). Percentage departures of rainfall are shown in brackets.

(AE- PE)/PE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अनावृष्टि अनुसंधान अनुभाग - पुणे
INDIA METEOROLOGICAL DEPARTMENT
DROUGHT RESEARCH UNIT - PUNE
भारत
शुष्कता विसंगति संचित्र
दिनांक से दिनांक तक
INDIA
ARIDITY ANOMALY CHART
From 30 - 07 - 09 To 05 - 08 - 09
शुष्कता की तीव्रता
ARIDITY INTENSITY
0 या उससे कम NON ARID AREA
1 से 25 तक MILD ARID AREA
26 से 50 तक MODERATE ARID AREA
50 से जादा SEVERE ARID AREA
मौसम विज्ञान उपमंडलो के नाम
NAMES OF METEOROLOGICAL SUB-DIVISIONS
1. Andaman & Nicobar Islands, 2. Arunachal Pradesh, 3. Assam & Meghalaya,
4. Nagaland, Manipur, Mizoram & Tripura, 5. Sub-Himalayan West Bengal & Sikkim,
6. Gangetic West Bengal, 7. Orissa, 8. Jharkhand, 9. Bihar, 10. East Uttar Pradesh,
11. West Uttar Pradesh, 12. Uttaranchal, 13. Haryana, 14. Punjab, 15. Himachal Pradesh,
16. Jammu & Kashmir, 17. West Rajasthan, 18. East Rajasthan, 19. West Madhya Pradesh,
20. East Madhya Pradesh, 21. Gujarat Region, 22. Saurashtra & Kutch, 23. Konkan & Goa,
24. Madhya Maharashtra, 25. Marathwada, 26. Vidarbha, 27. Chattisgarh, 28. Coastal Andhra
Pradesh, 29. Telangana, 30. Rayalaseema, 31. Tamil Nadu, 32. Coastal Karnataka,
33. North Interior Karnataka, 34. South Interior Karnataka, 35. Kerala, 36. Lakshadweep.

METEOROLOGICAL DROUGHT

- **BASED ON RAINFALL DEFICIENCY**, INDIA METEOROLOGICAL DEPARTMENT DEFINES METEOROLOGICAL DROUGHT ON SUB-DIVISION SCALE.
- THE METEOROLOGICAL DROUGHTS ARE CLASSIFIED INTO TWO FOLLOWING CATEGORIES:

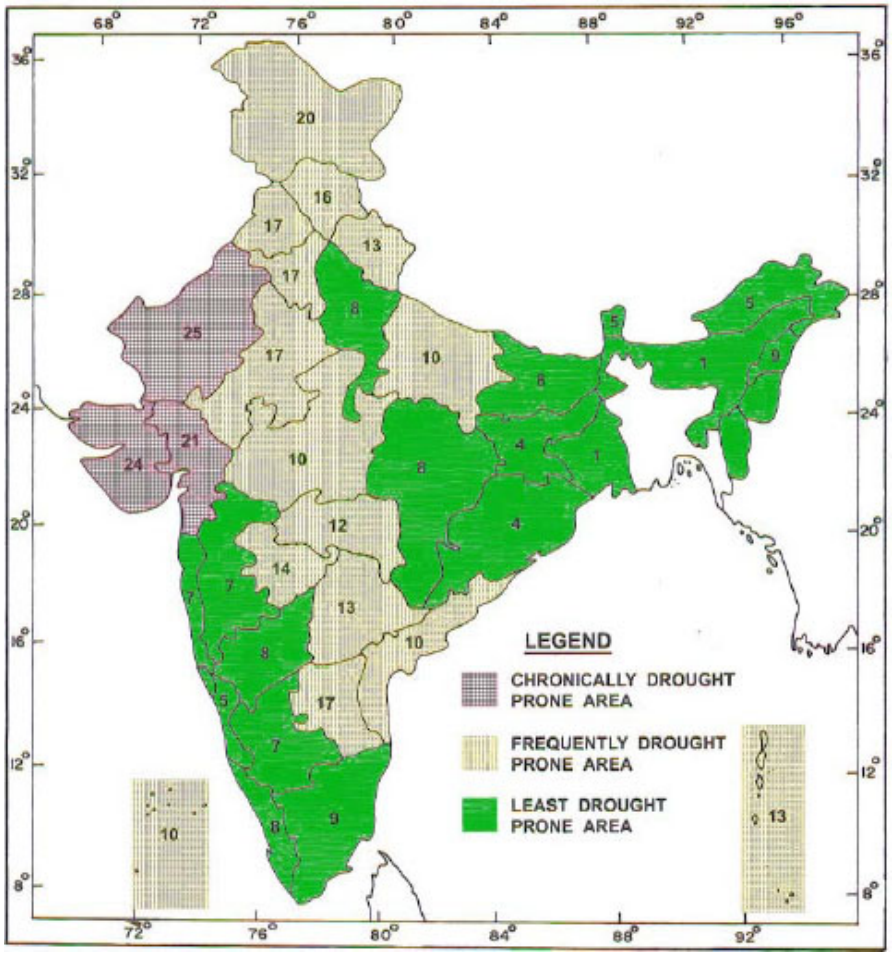
  (A) MODERATE DROUGHT : WHEN SEASONAL RAINFALL DEFICIENCY FALLS BETWEEN 26 TO 50%

  (B) SEVERE DROUGHT : WHEN SEASONAL RAINFALL DEFICIENCY EXCEEDS 50%.

Sub-divisionwise frequencies of Moderate and Severe drought during 1875-2004 and probabilities of drought years

S.No.	Name of Sub-division	Moderate	Severe	Drought T otal	probabilities(Total) %
1.	Andaman & Nicobar Islands	17	0	17	13
2.	Arunachal Pradsh	6	1	7	5
3.	Assam & Meghalaya	2	0	2	1
4.	Nagaland, Manipur, Mizoram & Tripura	12	0	12	9
5.	Sub-Himalayan West Bengal	7	0	7	5
6.	Gangetic West Bengal	2	0	2	1
7.	Orissa	5	0	5	4
8.	Bihar	11	0	11	8
9.	Jharkhand	5	0	5	4
10.	East Uttar Pradesh	12	1	13	10
11.	West Uttar Pradesh	10	1	11	8
12.	Uttaranchal	15	2	17	13
13.	Haryana, Delhi & Chandigarh	18	4	22	17
14.	Punjab	18	4	22	17
15.	Himachal Pradesh	18	3	21	16
16.	Jammu & Kashmir	20	6	26	20
17.	West Rajasthan	21	12	33	25
18.	East Rajasthan	17	5	22	17
19.	West Madhya Pradesh	13	0	13	10
20.	East Madhya Pradesh (including Chhattisgarh)	10	0	10	8
21.	Gujarat Region	16	11	27	21
22.	Saurashtra & Kutch	16	15	31	24
23.	Konkan & Goa	9	0	9	7
24.	Madhya Maharashtra	7	2	9	7
25.	Marathwada	17	1	18	14
26.	Vidarbha	15	1	16	12
27.	Coastal Andhra Pradesh	13	0	13	10
28.	Telangana	17	0	17	13
29.	Rayalaseema	20	2	22	17
30.	Tamil Nadu & Pondicherry	12	0	12	9
31.	Coastal Karnataka	5	0	5	5
32.	North Interior Karnataka	10	0	10	8
33.	South Interior Karnataka	9	0	9	7
34.	Kerala	10	0	10	8
35.	Lakshdweep	10	3	13	10

DROUGHT PRONE AREA



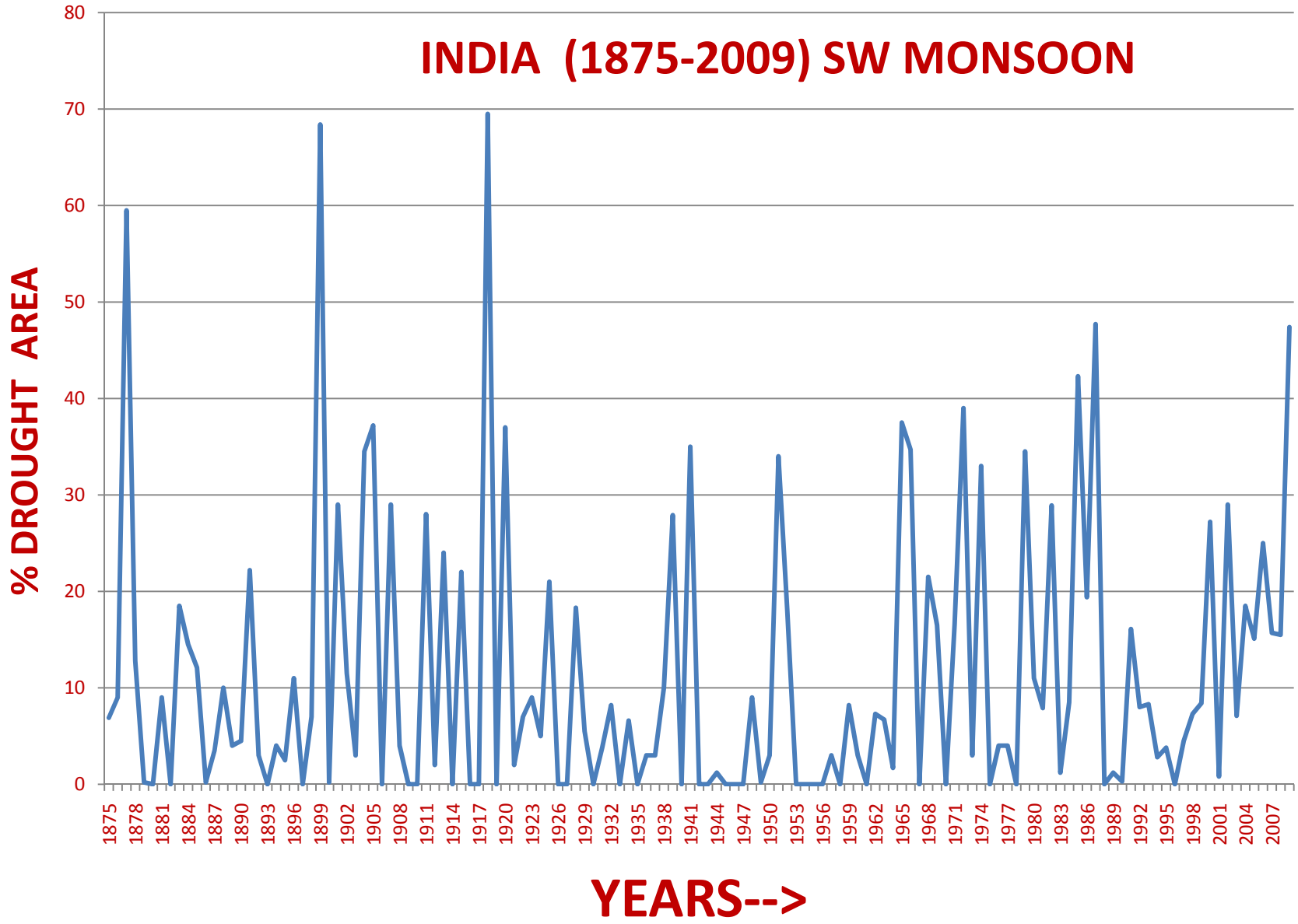
DROUGHT YEAR (COUNTRY)

MODERATE DROUGHT

- AREA AFFECTED 20 TO 40 % OF THE TOTAL AREA
- SOUTH-WEST MONSOON RAINFALL DEFICIENCY AT LEAST 10 % OR MORE

SEVERE DROUGHT

- AREA IS MORE THAN 40 %
- SOUTH-WEST MONSOON RAINFALL DEFICIENCY AT LEAST 10 % OR MORE


INDIA (1875-2009) SW MONSOON
% DROUGHT AREA
YEARS-->
0
10
20
30
40
50
60
70
80
1875
1878
1881
1884
1887
1890
1893
1896
1899
1902
1905
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
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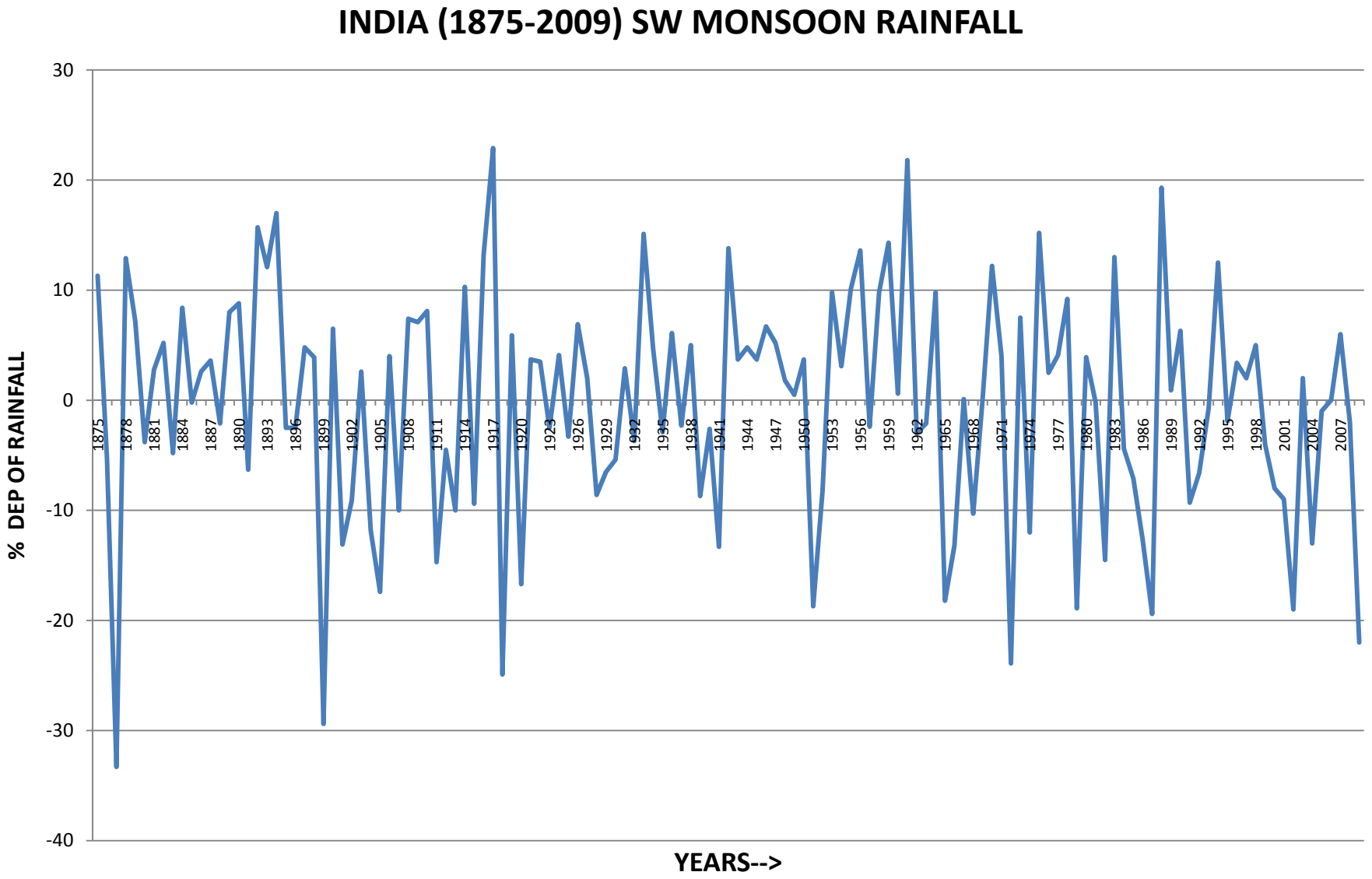
1995
1998
2001
2004
2007


INDIA (1875-2009) SW MONSOON RAINFALL
% DEP OF RAINFALL
30
20
10
0
-10
-20
-30
-40
1875
1878
1881
1884
1887
1890
1893
1896
1899
1902
1905
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
YEARS-->

SEVERE DROUGHT YEARS IN INDIA

YEAR	% AREA AFFECTED	% DEPARTURE OF RAINFALL IN AFFECTED AREA
1918	71	-49
1965	41	-36
1972	47	-35
1979	45	-38
1987	50	-45
2009	47	-41

- 40 DROUGHT YEARS SINCE 1801
- DROUGHT OCCURES AT A RECURRENCE INTERVAL OF 5 YEARS
- CONSECUTIVE 2 YEAR DROUGHT--4 OCASSIONS
- ALTERNATE YEAR --- 9 OCASSIONS
- DROUGHT PRONE AREA – 511300 Sq. Km.

DROUGHT MITIGATION

DROUGHT HAS LONG-TERM ADVERSE SOCIO-ECONOMICAL CONSEQUENCES AND SUFFERING TO POPULATION. THE COMMENCEMENT AND CONCLUSION OF DROUGHT IS UNKNOWN. DROUGHT IS REALIZED FROM ITS CONSEQUENCES WHEN IT IS WELL SETTLED. THUS, **PRE WARNING FOR SPECIFIC AREA IS NOT FEASIBLE** AND ONE NEEDS TO BE ALWAYS READY TO FACE THE DROUGHT SITUATION. HENCE, IT BECOMES THE RESPSIBILITY OF GOVERNMENT TO KEEP A CLOSE VIGIL ON DROUGHT SITUATION AND SHORT TERM IMMEDIATE PROGRAMES FOR RELIEF OF THE SUFERERS AND IMPLIMENT LONG TERM PROGRAMMES TO CHECK THE REFERENCES OF IT IN FUTURE.

THE MINISTRY OF HOME AFFAIRS IS A NODAL AUTHORITY FOR NATURAL DISASTER MANAGEMENT. THE OTHER COORDINATING AGENCIES ARE MINISTRY (S) OF AGRICULTURE, WATER RESOURCE, CIVIL SUPPLIES, HEALTH, SCIENCE AND TECHNOLOGY, DEPARTMENT OF SPACE, INDIA METEOROLOGICAL DEPARTMENT, RELIEF COMMISSION OF STATE GOVERNMENTS AND NON GOVERNMENTAL ORGANISITATIONS.

THE DROUGHT MITIGATION PROGRAMMES FALL IN 3 CATEGORIES AS SHORT TERM MEASURES, MEDIUM TERM MEASURES AND LONG TERM STRATEGIES.

SHORT TERM MEASURES

1. EXECUTION OF LABOR ORIENTED DEVELOPMENT SCHEMES AND FOOD FOR WORK PROGRAMMES TO CREATE PRODUCTIVE ASSETS

2. TRANSPOTATION OF DRINKING WATER BY RAIL AND ROAD TO AFFECTED AREAS

3. TUBE WELL CONSTRUCTION ON LARGE SCALE

4. HIGH PRIORITY TO WATER STORAGE PROJECTS .

5. RESERVIOR OPERATIONS BASED ON ADVANCE WEATHER FORECAST.

6. HIGH PRIORITIES FOR OPTING TO DROUGHT RESTRAINT CROPS WITH LESS WATER CONSUMPTIONS

MEDIUM TERM MEASURES

1. RAIN WATER HARVESTING AND WATERSHED MANAGEMENT:

2. ARTIFICIAL RECHARGE OF GROUND WATER

3. EARLY COMPLETION OF IRRIGATION AND WATER SUPPLY PROJECTS.

4. AGRO-CLIMATIC REGIONAL PLANING FOR BETTER SCIENTIFIC UTILIZATIO OF AVAILABLE WATER

5. DEVELOP EARLY MATURING CROP VARIETIES, DRY LAND FARMING TECHNIQUES AND INTRODUCTION OF WATRE SAVING OF CROPS.

6. ADOPTING MODERN IRRIGATION TECHNIQUES

LONG TERM STRATEGY

INDIA HAS DRAFTED NATIONAL WATER POLICY FOR WATER RESOURCE DEVELOPMENT AND ESTABLISHED NATIONAL WATER DEVELOPMENT AGENCY EXCLUSIVELY FOR ASSESSING WATER AVAILABILITY AND WATER DEMAND BASINWISE. CWC, CGWB, NIH, INDIA METEOROLOGICAL DEPARTMENT, MINISTRY OF WATER RESOURCES OF STATE GOVERNMENTS ARE ALSO CONTRIBUTING IN THIS TASK.

BASED ON WATER BALANCE STUDIES INDIA HAS ADOPTED FOLLOWING LONG TERM STRATAGIES

1. CREATION OF SURFACE AND GROUND WATER STORAGES
2. INTREGATION OF SMALL RESEVOIRS WITH MAJOR RESERVOIRS.
3. INTREGATED BASIN PLANNING
4. INTER BASIN TRANSFER OF WATER

LONG RANGE RAINFALL FORECAST

INDIA METEOROLOGICAL DEPARTMENT IS ISSUING LONG RANGE FORECAST FOR S-W MONSOON RAINFALL WHICH HIGHLIGHTS

EXPCTED DEPARTURE OF RAINFALL FROM NORMAL (PERCENTAGE) AND BECOMES WARNING TOOL FOR DROUGHT MITIGATION.

ALL THESE STRATEGIES ARE WELL PROVEN. INDIA COULD FACE THE SEVERE DROUGHTS OF 1987 AND 2009 NO STARVATION DEATHS OR SIGNIFICANT ADVERSE IMPACT ON ECONOMY WITHOUT ANY EXTERNAL HELP OR ASSISTANCE.

Thank You for your cooperation