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# Drought Proofing - Essential Strategy for Drought Relief and Management

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## 1. Preamble:

Indian Economic Development is largely dependent on monsoon from the point of view of agriculture, drinking water and resultant socio economic development. Water is a natural resource; it is an essential requirement for survival of human life and for maintenance of biodiversity and quality of environment. Agro economic and industrial development is also dependent on water. Water therefore is the backbone of overall human development covering food security, hygiene, economical growth and ecological security.

Requirement of Fresh Water for Irrigation as well as Domestic and other non-agricultural use has been continuously growing along with the population growth. Agricultural production has significantly increased over a period of last 10 to 15 years. The compound growth of agricultural production was 1.73% during the period 1990-1991 to 2000-2001. This has increased to 4.1% in the year 2016-2017. This is a significant growth. At the same time, the requirement of water resources for agriculture is also increasing year to year. The average annual water resources potential in India has been assessed as 1869.3 Billion Cubic Meters (CWC, 1993). The estimated per capita average annual water availability in the year 2010 was 1608 Cubic Meters. This will reduce to 1341 Cubic Meters in 2025 and 1139 Cubic Meters in 2050.

Water is also an essential input for industrial development in the Country. Agro based industries are also developing fast. This also significantly adds to the requirement of water. Water is therefore an essential and key input for overall socio economic development of India. Water management, therefore, needs focused attention specifically from the point of view of drought management.

Vagaries of monsoon have critical impact on the countries' economic growth. Fluctuations in the nature of rainfall lead to degradation of natural resources, unstable agriculture production as well as insecurity of food and livelihood. In India, pattern of rainfall changes from State to State and the number of rainy days also varies frequently year to year. Water demand for agriculture, drinking water and industrial development is continuously increasing from decade to decade along with the increase in population

and with the hike of people's expectations and perceptions. Water demand is increasing day by day but the water availability has been also reducing. Vagaries of the monsoon lead to frequent and widespread drought conditions in one or the other State from time to time. India has abundant ground water sources. However, the ground water table has been continuously depleting because of over drawl. Ground Water Quality has also been a big challenge in management and use of water. States of Gujarat, Madhya Pradesh, Parts of Maharashtra have suffered because of excessive fluorides in ground water. In coastal regions salinity ingress of sea water into the Ground Water has increased salinity in water. In the state of West Bengal, Orissa and Bihar arsenic in ground water has been a major threat to the quality of human life and health.

**2. Gujarat Scenario:**

Gujarat, covering an area of about 19.59 million hectares can be divided into three regions depending on the rainfall and soil characteristics as under:

1. Gujarat region having an average annual rainfall varying from 500 to 2000 mm.
2. Saurashtra region with an average annual rainfall varying from 400 mm to 700 mm and some areas 500 to 1000 mm
3. Kachchh region with an average annual rainfall varying from 250 to 400 mm

There are wide regional variations in the annual rainfall ranging from an average of 1875 mm in Dang District located in the southern region to 377 mm in parts of Kachchh located in the western region. This is compounded by fluctuation in rainfall from year to year with the coefficient of variation ranging from 25% in Dangs to 80% in Lakhpat Taluka of Kachchh.

Out of the total geographical area of 1,95,984 sq.kms, 1,09,304 sq.kms is covered by hard rock and 86,680 sq.kms with alluvial deposits.

The State is divided naturally into three geographical units.

1) The Gujarat Mainland,
2) The Saurashtra Peninsala, and
3) Kachchh region.

a) The Gujarat mainland comprises of extensive alluvial plain flanked by hilly terrain to the east. The land slopes gently towards the west and south west and is traversed by five major rivers, Tapti, Narmada, Mahi, Sabarmati and Banas and other small streams. Total geographical area of Gujarat main land is 92421 sq. km.

b) The Central part of the Saurashtra peninsula is elevated and the land slopes very gently towards the coast and the plains of the Gujarat Mainland. Most of the rivers originate in this central land and run radially into the sea. The central

portion of the peninsula is characterized by low hills, and deccan trap rock. Geographical area of Saurashtra penninsula is 59360 sq.km.

c) The Kachchh land mass (crescent shaped) is sloping towards the Great Rann in the North and the Little Rann and the Bay of Kachchh in the South. The soils are generally derived from Sandstone and lime stones and are coarse in texture. Large land areas are affected by salinity; Total geographical area of Kachchh is 44203 sq. km. out of which 22617 sq. km. is Rann area.

The geological and geo-hydrological situation in Gujarat is peculiar. The State has a coastline of about 1600 km length. About 66% of the total area of the State is rocky and hence unsuitable for holding significant quantum of ground water. Out of the balance area of 34%, about 4% is coastal saline and the remaining 30% holds adequate ground water. **In absence of major perennial rivers (except Narmada), water sources directly depend on rainfall.**

The agriculture growth rate of Gujarat through all crops was 2.8% per annum from 1960-61 to 1980-81. The total food grain production in the year 2008-09 was 6345100 Metric Tonnes. In the year 2010-11, the production stands at 10070600 Metric Tonnes. In the year 2012-13, the production is 8680000 Metric Tonnes. The total area irrigated in Gujarat in the year 1961-62 was 0.8 million Hectares against the gross cropped area of 10.1 million hectares. Thus, about 8% of the cropped area received irrigation. By the year 1977-78 irrigated area increased to 1.9 Million Hectares, out of total cropped area of 10.4 Million Hectares. In past irrigation development in Gujarat was predominantly based on ground water sources. These sources are depleting. Requirement of water for irrigation is increasing due to increase requirement of food and non-food agriculture. Groundwater is no more dependable due to depletion of groundwater and deterioration in quality due to over exploitation. Gujarat Economy depends on growth of agricultural and industrial growth. Making available water to meet with the demand is therefore a prime input for the development of economy. Augmenting and managing distribution of surface water resources is therefore critically important.

A study undertaken in September 2000 had indicated that annual renewable per capita water availability was 1137 $M^3$. Water availability at that point of time was found to be 474 $M^3$ per Capita in north Gujarat in contrast to 1937 $M^3$ in south and central Gujarat where 70% of the State's fresh water resources are concentrated in South and Central Gujarat.

As the water sources are rain fed, the scanty rainfall apart from affecting agricultural production leads to acute scarcity of drinking water. Droughts in

Gujarat has been fairly a regular phenomenon. Until 2001, droughts were observed every third year in Gujarat.

## 3. Droughts in Past:

### 3.1 1972-73 Drought:

The State had faced severe drought way back in the year 1972 – 73. Large number of urban and rural areas had faced drinking water scarcity. City of Rajkot was almost without water as its water resources were all dried up. It became necessary to implement a 90 Kms emergency pipeline Project in a record period of 90 days for drinking available water in Bhadar dam to Rajkot. Incidentally late Shri V.D. Tank was actively involved in conceptualizing and implementing this Project. Jamnagar City was connected to Und – II, Sasoi and Ranjit Sagar Dams. Bhavnagar and Amreli were connected to Shetrunji and Khodiar Irrigation Reservoirs. Porbandar was supplied water from Fodarnes Dam. Junagadh was connected to Hasnapur Dam. Rajkot had multiple connectivity with Aji – I and Aji – III reservoirs along with Bhadar Dam. These were at that point of time thought to be long term drought proofing arrangements. However, all these reservoirs are rain fed and when the rains fail, these cities suffer acute water scarcity.

### 3.2 Droughts in 1985-86 to 1999-2000:

The State reeled under acute drought conditions for three consecutive years i.e. 1985-86, 1986-87 & 1987-88. 1992-93 was also a semi drought year when water shortage was a predominant issue. Again 1999-2000 was also a drought year. In 1985-86 the availability of surface water storage in irrigation reservoirs was 24.62% of the total capacity. In the year 1999-2000, this was hardly 12.7%. Most of the rain fed surface water reservoirs in the State had dried up. In the year 1985-86, it had become necessary to transport water from Gandhinagar to Rajkot through rail tankers on emergency basis.

The Irrigation Commission (1972) setup by the Government of India had identified 60 Talukas in 11 Districts of Gujarat State as drought prone areas. These districts were Banaskantha, Mehsana, Ahmedabad, Kheda, Bharuch, Kachchh, Surendranagar, Rajkot, Jamnagar, Bhavnagar and Amreli. Providing drinking water both for agriculture and drinking water on a sustainable basis to the rural and urban masses of the people in Gujarat was an issue of major concern since the time prior to the existence of Gujarat. Government had taken up various measures for mitigating water scarcity as a part of its emergency drought management efforts and had spent huge amount of money for the purpose. Expenditure on drought relief has been huge as can be seen from the historical data presented here under:

| Sr. No. | Year | Affected Villages | Affected Towns | Expenditure incurred to mitigate drining water problem Rs. million |
|---|---|---|---|---|
| 1 | 1985-86 | 10280 | 24 | 867.2 |
| 2 | 1986-87 | 1137 | 17 | 465.0 |
| 3 | 1987-88 | 15646 | 29 | 1120.0 |
| 4 | 1990-91 | 2368 | 5 | 65.10 |
| 5 | 1991-92 | 6931 | 60 | 389.8 |
| 6 | 1992-93 | 902 | - | 23.0 |
| 7 | 1993-94 | 4954 | 15 | 271.0 |
| 8 | 1994-95 | 1385 | - | 41.20 |
| 9 | 1995-96 | 8327 | 33 | 633.17 |
| 10 | 1996-97 | 8666 | 27 | 856.86 |
| 11 | 1997-98 | - | - | 264.41 |
| 12 | 1998-99 | 5889 | - | 431.15 |
| 13 | 1999-2000 | 3227 | - | 218.19 |
| | | | **TOTAL Rs.** | **5645.78** |

Drought Management efforts were largely focused on temporary and repetitive actions. Fund has to be allocated for these measures from the calamity relief fund as well as budgetary supports by the State Government. Transportation and supply of water through road tankers was a major activity to mitigate the drought conditions. From 1985-86 to 1999-2000, 610 million rupees were spent in supply of water through tankers.

**1. Drought Mitigation & Management Strategies:**

**4.1 Strategy during Moghal & British Rule:**

India has faced droughts time and again in different parts of the Country since the days of Moghal Rule in India. The then emperors had carved out policies and strategies to mitigate the drought conditions aiming at deepening of ponds and digging of wells. Drought conditions continued during the British Rule also. The first Famine

Commission was set up in 1968 and temporary measures to provide relief to the people were defined and put in place.

The first Scarcity Manual was prepared by the British Rulers in 1883. Provincial Government had also prepared their own manuals using this Central Manual. The strategies and efforts were focused on providing relief until the next monsoon. The approach of the Government of India after independence to meet with the drought conditions aimed at implementing Drought / Scarcity relief work and put in place Drought Prone Area Development Programs i.e. Special Programs aiming at development of drought and dessert prone areas. Though, this looked to be a combination of temporary relief measures and long term development, focus was still on temporary reliefs.

**4.2 Gujarat Strategy from 1972 to 1999:**

Drought in Gujarat was also considered as a natural calamity demanding immediate relief as and when the drought happened. The Gujarat Relief Manual 1982 revised in 1987 has been in place for long to mitigate scarcity situations. The approach to mitigate scarcity and drought conditions was based on short term relief without focused attention on multiple impact on droughts in drought areas. Though, drinking water was given priority, emphasis was on relief through supply of water through tankers, deepening of existing wells, developing new wells, drilling shallow and deep bores. As has been said earlier, huge money was spent on these temporary measures. Historical Data indicates that during the period 1990 to 2009 Rs. 243 Crores were spent on supply of water through road and rail tankers.

Ground water in Gujarat has been continuously depleting both in terms of quantity and quality. Wells, tube-wells, failed time and again. People in the Rural Areas particularly the females had to spend almost 3 to 6 hours every day in search of water for drinking and household use. Women did not get time to do work to earn. Girls had to dropout from schools.

**4.3 Concept of Regional Rural Water Supply Schemes:**

From 1990-91 to 1999-2000, Government of Gujarat had spent Rs. 2541 Crores in setting up Regional Rural Water Supply Schemes. Rs. 110 Crores were spent on their operation and maintenance. During the decade 1990 to 2000, a strategy of putting in place regional rural water supply schemes covering 25 to 60 villages in groups based on battery of ground water resources. Some schemes like the Morbi – Maliya Regional Rural Water Supply Scheme were based on surface water reservoirs. These sources were again rain fed and during drought conditions, the reservoirs were bone dry and people had to face acute water problems. However, the water sources were not sustainable as they were either ground sources which depleted time and again or surface sources which were rain fed. Villages covered under the Regional Rural Water Supply Schemes suffered acute water scarcity due to depletion of groundwater table and deterioration of groundwater quality. Wells were deepened to depths ranging

from 20 to 30 meters and tube-wells in North Gujarat were drilled to depths of 270 to 290 meters.

**4.4 Desalination and De-fluoridation:**

Efforts were also made to set up Reverse Osmosis Plants to convert brackish water into potable water. De-fluoridation plants were also set up at a total cost of Rs. 142 Crores to provide potable water in the fluoride affected areas. Technology was not that complex and difficult. However, its operation and maintenance at village level was found to be difficult and not cost effective. These solutions did not ensure water security and sustainability.

**4.5 Rain water harvesting:**

Harvesting of rain water through development and construction of large number of check dams was thought to be a drought proofing measure. 168311 check dams have been constructed so far in Gujarat. The concept of providing Bori Bandh also developed so as to store water when the rivulets, nallahs and water streams were flooded in monsoon. 125541 Bori Bandhs have also been constructed. 261988 Khet Talavdis have also been constructed. Water stored in these water conservation structures did maintain some storage during the year and provided water for local irrigation use. Again these structures were dependent on rainfall and do not sustain water storage during drought conditions when the monsoon fails. The storage developed in good years is also not commensurate with the increased demand for agriculture and non-agriculture consumption.

The Drought Management Policies and Strategies required a paradigm shift so as to ensure "**Water Security**" on a long term and sustainable basis.

**2. Gujarat – Paradigm Shift:**

**5.1 Concept:**

In the decade of 1970 to 1980, supply of drinking water to the urban and rural community was dependent largely on ground water sources particularly in Saurashtra, Kachchh and North Gujarat. Individual Village Water Supply Schemes based on open wells were developed and implemented in Saurashtra Region. In North Gujarat and in Kachchh such schemes were dependent on deep tubewells. Ground water table in Saurashtra, Kachchh and North Gujarat was continuously depleting. Droughts added to the shortage of potable drinking water from ground sources. A change in the drought and water management policy was the need of the day.

The Government of Gujarat, immediately after the drought conditions in the year 1999-2000 adopted a Paradigm Shift, in the age old policy of Drought Management and evolved a strategy to put in place water security through implementation of Drought Proofing measures rather than temporary Drought Mitigation. Gujarat has 55.61 Billion Cubic Meters of Water available in the State. Out of this, 38 Billion Cubic Meters (68.5%) is surface water and 17.5% Billion Cubic Meters is ground water. Storage capacity of existing reservoirs (except Sardar Sarovar) is 15000 Million Cubic

Meters. These reservoirs are rain fed and susceptible to the vagaries of the monsoon. The Regional Rural Water Supply Schemes that were implemented prior to 2000, were largely based on ground and surface water sources. Ground sources were depleting along with deterioration of water quality. Surface water sources were dependent on rains. These schemes were therefore not able to ensure water security and sustainability. Narmada is a major perennial river passing through Gujarat.

The Government of Gujarat conceived a policy of putting in place a water grid based on reliable and sustainable rivers like Narmada so as to ensure drought proofing and water scarcity. The Government had conceived a Master Plan to provide water from the Narmada Canals to 8215 villages and 135 towns in the late 1990s. However, immediately after conceptualizing the Drought Proofing and Sustainable Water Security strategy in 2000, the Government of Gujarat approved the Master Plan for providing a large water grid based on the Narmada Canals for supply of safe and secure drinking water to the rural and urban population of Saurashtra, Kachchh, North Gujarat and Panchmahals. Strong Political & Administrative Will with engineering commitment and capability to provide water security and sustainability through Drought Proofing measures.

**5.2 Asia's largest Narmada based water grid:**

Asia's largest water grid comprising of 3250 Kms of large and medium diameter pipelines based on Narmada Canals was implemented. Until 2010, 6513 villages and 114 towns were supplied with Narmada water.

As of now, 47 bulk pipeline Projects with 2684 Kms of bulk pipelines along with 236 multi village water supply schemes have been completed. 120769 Kms of distribution pipelines for distributing Narmada Water in 11220 villages and 171 towns have been completed. 47 million people are supplied with 2950 MLD of drinking water from the Narmada Canal. This has been a huge task and the Government of Gujarat with political will and active contribution by engineers and administrators, has successfully implemented the water grid as a part of its Drought Proofing and Water Security Strategies. Narmada Waters have reached remote areas of Saurashtra, Kachchh and North Gujarat. This water grid has turned out to be a major step towards long term drought proofing and water security in the State.

**3. Interlinking of Rivers:**

Along with the successful implementation of the Narmada Based Drinking Water Supply Program, the Government of Gujarat has also focused on interlinking of Rivers. River Narmada is already linked with River Sabarmati through Canal Network which transfers Narmada Water into River Sabarmati with benefits accruing to the City of Ahmedabad and nearby areas. The Government of Gujarat has also taken up the implementation of connecting 115 existing Dams and Reservoirs on non-perennial rivers of Saurashtra to the Narmada Canal Network. The overflowing water of the Narmada Dam will be sent through the network of canals and 1126 Kms long large

diameter pipeline to 11 Districts of Saurashtra. Machhu, Bhogavo, Aaji, Hiran and other rivers in Jamnagar, Amreli, Rajkot and Junagadh Districts will be linked with the River Narmada through its Canal Network. This again is a very major approach and strategy to ensure Drought Proofing and Water Security.

**4. Conclusion:**

Government of Gujarat has put in place effective and efficient strategy to provide long term water security so that Drought becomes a matter of past. This will enable significant improvement in the "Quality of Human Life" as enshrined under Article 21 of the Constitution of India as a part of fundamental "Right to Life". Large Capital assets in the form of Canal Network, bulk water pipelines, and distribution pipelines have been created. Policy initiatives with a paradigm shift as already said have been implemented and there will be more and more initiatives aiming at water security will still come up. Water demand has been steadily increasing due to change in life styles and the process of urbanization. People's expectations in terms of effective and efficient delivery systems have been also rising. Community awareness is also significantly increased. Efficient Operation and Maintenance adopting least cost approaches aiming at reliable and sustainable delivery mechanisms so as to reach drinking water to all who are still not reached will be the key to success of the Water Security strategies. Appropriate tariff mechanisms, legal and regulatory framework will also have to be put in place.

The Institutions responsible for supply of water like the Municipal Corporations, Municipalities, Gram Panchayats at the Local Self Government Level and the State Institutions like the Irrigation Department, Gujarat Water Supply & Sewerage Board, Gujarat Water Infrastructure Limited, Narmada Nigam, and other such Institutions will have to continue to work hand in hand with close coordination and pragmatic approaches to ensure that "Right to Water" as a part of "Right to Life" enshrined under Article 21 of the Constitution of India is available to the people of Gujarat.

This is again a major task and I am sure the task can be achieved with strong Political Will, efficient administrative mechanism and commitment to cause on the part of the Engineering Fraternity.

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