



**Module 9 – (L35 – L37):**

**“Drought Management”:**

**Drought assessment and classification, drought analysis techniques, drought mitigation planning.**

# **WATERSHED MANAGEMENT**

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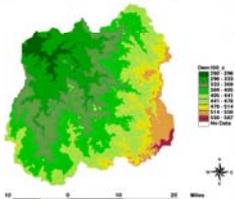
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Lecture No- **37** **Drought Mitigation**

## L37– Drought Mitigation

- **Topics Covered**
- Drought mitigation & management, warning, monitoring, mitigation & planning,
- **Keywords:** Drought mitigation; Management & Planning

Digital Elevation Model Anas river watershed (Jhabsud, India)



## Introduction

- Mitigating drought: Taking actions in advance of drought to reduce its long-term risk
- Involve a wide range of tools: policies, activities, plans, and programs

### Components of a drought mitigation plan

- Prediction
- Monitoring
- Impact assessment
- Early-warning systems
- Action plans to deal with severity
- Relief & responses



## Introduction - Mitigation

- **Mitigation actions**, programs, & policies are implemented **during and before drought** to reduce the magnitude of risk to human life, property, and productive capacity.
- **Shift in public policy from drought relief to drought mitigation measures.**
- Important for adapting to climate change, restoring ecological balance, and bringing development benefits to the people



## Drought Mitigation - Strategies

- Alternative cropping strategies, soil and water conservation and promotion of water harvesting techniques – examples for emergency drought relief.

Main objectives, to combat drought are:

- (a) To develop national strategies for drought preparedness in both the short and long-term, aimed at reducing the vulnerability of production systems to drought
- (b) To strengthen the flow of early-warning information to decision makers and land users to enable nations to implement strategies for drought intervention
- (c) To develop & integrate drought-relief schemes and means of coping with environmental refugees into national and regional development planning

## Drought mitigation commitments

- Improve land and water management – Watershed based scheme – more effective
- Soil management
- Promote agricultural management & provide trainings
- Develop strategies for drought preparedness
- Mobilize Financing
- Afforestation & reforestation
- Necessities of the communities
- Social issues

## Drought Monitoring & Early Warning

- Drought - Typically a slow-onset phenomenon
- Often possible to provide early warning of an emerging drought
- Early warning allows for a shift from reactive to proactive hazard management

Drought monitoring techniques across the world

- **China** - Standardized Precipitation Index to monitor drought occurrence
- **United States** - Multiple climate indices and indicators

## Drought Monitoring & Early Warning

- **Australia** - Quantifies precipitation percentiles
- **Africa** - Famine Early Warning System (FEWS NET)
- **Afghanistan, Pakistan and western parts of India** - South Asia Drought Monitor (SADM)
- **SADM** - Based on remote sensing data, drought related indices and GIS
- **FEWS NET** is mainly focused on Africa, where the majority of food security warning systems operate, but it also covers parts of Central Asia, Central America, and the Caribbean

## Drought Mitigation & Preparedness Measures

### Mitigation Measures & Preparedness:

- **Structural/physical** (e.g., appropriate crops, sand dams, engineering projects)
- **Non-structural** (e.g., policies, awareness etc..)
- **Preparedness:** Defined as pre-disaster activities that are undertaken within the context of disaster risk management and are based on sound risk analysis

### Examples:

- **Water scarcity during the dry season** (problem) ?- the groundwater dam (Solution)!



## Drought Mitigation & Preparedness Measures

### Mitigation Measures & Preparedness:

- Most important steps in lessening the effects of drought though are **soil and water conservation**.
- By **protecting soil**, it is better able to absorb precipitation, but it can also help farmers to use less water
- It also creates less water pollution by the pesticides and fertilizers present in most farm runoff.
- **Water conservation** - public use is often regulated. Water conservation devices like low-flow toilets, shower heads, and washing machines
- Desalination of seawater, **water recycling, & rainwater harvesting**



## Drought Mitigation & Protection

### Mitigation Measures & Protection:

- Dams - many dams & their associated reservoirs supply additional water in times of drought.
- Cloud seeding - an artificial technique to induce rainfall.
- Desalination of sea water for irrigation or consumption.
- **Drought monitoring** - Continuous observation of rainfall levels & comparisons with usage levels- help prevent man-made drought.
- Eg: Analysis of water usage in Yemen - revealed that their groundwater table - at grave risk by over-use for Khat crop.
- **Monitoring of moisture levels** - help predict increased risk for wildfires, using such metrics as Palmer Drought Index.



## Drought Mitigation & Protection

### Mitigation measures & Protection:

- **Land use** - planned crop rotation - minimize erosion & allow farmers to plant less water-dependent crops in drier years.
- Outdoor water-use restriction - Regulate use of sprinklers, hoses or buckets on outdoor plants, filling pools, & other water-intensive home maintenance tasks.
- Rainwater harvesting - Collection & storage of rainwater from roofs or other suitable catchments.
- Recycled water - wastewater (sewage) treated & purified for reuse.
- Transvasement - Building canals or redirecting rivers as massive attempts at irrigation in drought-prone areas.



## Drought Mitigation & Preparedness Measures

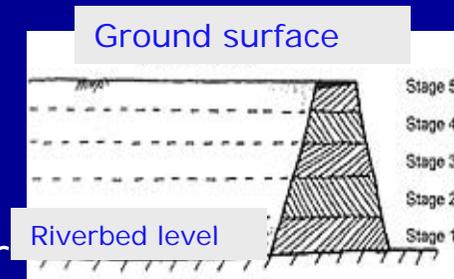
- **Examples:**
- **Groundwater dams**- Store water underground, rather than on the surface
- Ex: "Mother's Water Cellar" project launched in August 2000 by China Women Development Foundation -Now, provides readily accessible potable water for about one million people in rural China
- **Percolation tanks**- for Groundwater Recharge
- Survival of about 15 million farmers living in the semi-arid basaltic plateau in Western India

## Drought Mitigation – Groundwater Dams

- **Groundwater dams** - structures that intercept or obstruct natural flow of groundwater & store water underground
- Basic principle : instead of storing the water in surface reservoirs, water is stored in underground - less contamination
- No problem of submergence of land

### Sub-surface dam:

- Intercepts or obstructs the flow of an aquifer
- Reduces variation of level of groundwater table upstream of the dam.
- It is built entirely under the ground

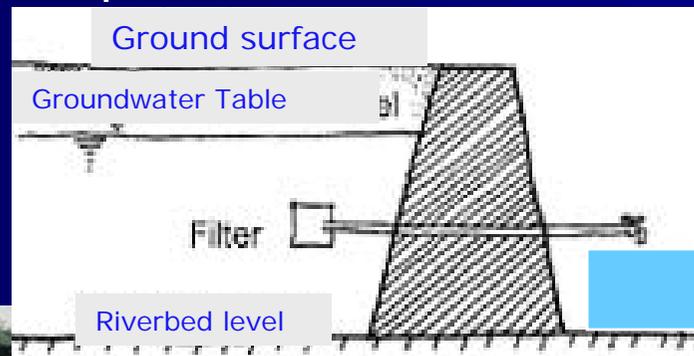


[http://www.rainwaterharvesting.org/rural/Contemporary\\_more.htm](http://www.rainwaterharvesting.org/rural/Contemporary_more.htm)

## Drought Mitigation – Groundwater Dams

### Sand storage dam:

- Constructed above ground
- Sand & soil particles transported during periods of high flow are allowed to deposit behind the dam
- Water is stored in these soil deposits (figure)
- Sand storage dam - constructed in layers to allow sand to be deposited & finer material be washed downstream



[http://www.rainwaterharvesting.org/rural/Contemporary\\_more.htm](http://www.rainwaterharvesting.org/rural/Contemporary_more.htm)

## Technology for Drought Reduction

### *Field agricultural technology:*

- Straw or plastic film mulch, conservation tillage and rainwater harvesting
- water saving technology such as hole irrigation, surge flow irrigation, micro-irrigation and drip-irrigation

### *Water-saving technology of chemistry*

- Drought-resistant and water save technologies
- For preserving soil moisture and reducing crop transpiration

### *Water storage cellar, sea water desalination, wastewater treatment*

- Water cellar - digging cellar to collect rainwater

## Technology for Drought Reduction

- Development of drought plans or reporter on drought impact
- **Ex:** "Drought monitoring index on the national and global basis"
- Implemented by Beijing Climate Centre (BCC), China Meteorological Administration (CMA)
- Several routine products for China and the globe are produced on a daily basis from real-time station-based and satellite-derived data
- **Available for free downloading from the web page of BCC**

## Impact Sectors

Mitigation actions can be categorized according to 11 impact sectors

- Water Availability,
- Municipal Water,
- Water Shortage/Conservation Activities,
- Agricultural Industry,
- Public Information and Education,
- Fish/Wildlife Preservation,
- Health,
- Commerce and Tourism/Economy,
- Wildfire Protection/Forestry/Public Lands,
- Energy, and Social

## Mitigative strategies

Mitigative strategies be divided into 9 categories:

- Assessment Programs
- Legislation/Public Policy
- Water Supply Augmentation
- Public Awareness/Education Programs
- Technical Assistance
- Demand Reduction/Water Conservation Programs
- Emergency Response Programs
- Water Use Conflict Resolution, and
- Drought Contingency Plans

## Legislation/Public Policy

*Specific actions taken by Government:*

- Prepare position papers for legislature on public policy issues
- Examined statutes governing water rights for possible modification during water shortages
- Pass legislation to protect instream flows
- Pass legislation providing guaranteed low-interest loans to farmers
- Impose limits on urban development

## Challenges of Drought Monitoring

- **Meteorological and hydrological** data networks are often inadequate in terms of the density of stations
- Data quality is also a problem because of missing data or an inadequate length of record
- **High cost of data limits** their application in drought monitoring, preparedness, mitigation and response
- **Information** delivered through early warning systems is often too technical and detailed, limiting its use by decision makers
- **Forecasts** are often unreliable on the seasonal timescale and lack specificity, reducing their usefulness for agriculture and other sectors
- **Drought indices** are sometimes inadequate for detecting the early onset and end of drought

## Challenges of Drought Monitoring

- **Drought monitoring** systems should be integrated, coupling multiple climate, water and soil parameters and socio-economic indicators
- For fully characterizing drought magnitude, spatial extent and potential impact
- **Impact assessment methodologies**, a critical part of drought monitoring and early warning systems, are not standardized or widely available
- Hindering impact estimates and the creation of regionally appropriate mitigation and response programmes

## Drought Management -Mitigation Strategies

- **Drought warning systems** -Availability of Inputs
- Judicious use of surface & groundwater
- Cloud seeding in Drought Prone regions
- Micro Irrigation Systems
- Post Harvest Management
- Nutritional Aspects of Food Security
- Water Conservation, Storage Structures & Management
- Afforestation
- Crop Insurance
- Capacity building
- Community participation
- Relief & responses -Public Distribution System
- **Appropriate drought management plans** - Guidelines

## Case Study: Drought Analysis in Rajasthan

- **Ref:** State Level Analysis of Drought Policies and Impacts in Rajasthan, India, M.S. Rathore, IWMI, 2005, Working Paper 93
- **Rajasthan**- one of the largest State of India- area of 342,000 km<sup>2</sup> (10%) & population of 56.5 million (5%) & only **1% of India's water resources** – economically backward.
- **Climate** - varies from arid to sub-humid; average rainfall - **574 mm** -varies significantly- western Rajasthan, average annual rainfall less than **100 mm**
- In Rajasthan, about **50 drought years since 1901**
- Detailed analysis- in **9 out of 102 years** were none of the **districts in the State** affected by droughts.
- Every year some part(s) of Rajasthan- affected by drought.
- State considers drought as a **transient phenomenon** - plan **shortterm** relief measures – not solution.

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## Drought Analysis in Rajasthan

- **Ref:** State Level Analysis of Drought Policies and Impacts in Rajasthan, India, M.S. Rathore, IWMI, 2005, Working Paper 93
- **Drought Index (DI)** =  $(P - X) / SD$ , P- annual precipitation, X- long term mean and SD- standard deviation
- **DI - classified into four:** DI =  $\leq -0.1$  light drought, DI =  $\leq -0.2$  moderate drought, DI =  $\leq -0.5$  severe drought, DI =  $\leq -0.8$  very severe drought.
- **48 out of 102** years were drought years - chance of occurrence of a meteorological drought in the state is 47%
- **Vulnerability to drought:** both low-income and middle-income households are vulnerable to droughts; **Indicators:** forced migration, borrowings, food shortage, change of occupation, forced unemployment, falling health conditions etc.



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## Drought Analysis in Rajasthan

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*Frequency and intensity of droughts in Districts of Rajasthan during 1901-2002*

Region	Number of years with droughts of different intensity				% of all drought years in the period
	Very Severe	Severe	Moderate	Light	
Western Region	12	12	11	11	45.0
NE Region	12	8	11	16	46.0
Southern Region	10	12	9	12	42.1
All Rajasthan	10	10	15	13	47.0

### Drought perceptions & implications:

Perceived as creeping phenomenon- onset & end difficult to identify.

Viewed as a transient phenomenon.

Direct impacts- withering crops, dry watering points, reduced forage for livestock etc., are obvious.



## Drought Impacts in Rajasthan

- **Ref:** State Level Analysis of Drought Policies and Impacts in Rajasthan, India, M.S. Rathore, IWMI, 2005, Working Paper 93

*Annual statistics of drought impacts in Rajasthan*

Finance Year	District affected (%)	Human affected (%)	Livestock Population affected (%)	Foodgrain Production Index
1970-71	26.92	1.35	2.28	140.24
1971-72	50	17.3	8.79	100.52
1972-73	100	52.77	47.37	81.84
1984-85	77.73	27.38	26.74	125.58
1985-86	76.3	70.44	61.4	125.88
1986-87	100	82.54	65.96	107.76
1987-88	100	92.27	74.98	76.25
1995-96	93.55	62.47	59.09	151.81
1996-97	67.74	14.37	15.2	203.44
1997-98	75	11.27	NA	222.67
1998-99	62.5	48.83	54.42	205.23

## Drought Impacts in Rajasthan

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### *Impact of drought in Rajasthan*

Item	1988	1998	1999	2000	2001	2002
Villages affected	36,252	20,069	23,406	30,583	7,964	40,490
Population affected (million)	31.737	21.507	26.179	33.041	6.97	44.8
Cattle affected (million )	37.23	29.578	34.56	39.969	6.973	45.2
Crop damage						
Area (million ha)	7.436	6.496	7.818	8.947	2.653	11.7
Value (million US \$)	539.1	496.4	740.6	763.4	272.2	959.5
Rainfall deficiency	-45%	-3%	-16%	-29%	-5%	-64%

## Drought Management in Rajasthan

- **Institutions for drought management:** Task force & committees – State Govt. controlled
- **Drought monitoring & early warning** – IMD, Weather Watch Group: Based on Rainfall data, water levels in reservoirs & crop prospects.
- **Drought Mitigation Programmes:** Rural development Programme – Infrastructure, new crop, watershed
- **National Watershed Development Programme** for Rainfed Areas (NWDPR) and Integrated Watershed Development Programme (IWDP)
- **Drought Prone Area Development Programme (DPAP)**
- **Desert Development Programme (DDP)**
- **Employment Generation Programme (EGP)**
- **Rural Poverty Alleviation Programmes** – Food assistance<sub>29</sub>

## Concluding Remarks

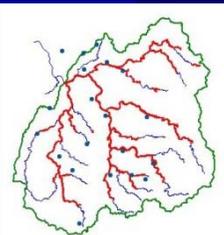
- **Main issues - policy formulation and action:**
  - (i) understanding the nature of drought, (ii) modifying perception & response to drought, (iii) changing approach- relief to mitigation of drought.
- Identification of vulnerable areas and population.
- **Impact of drought** is both direct and indirect on most of the economic and social parameters.
- Water availability is the key
- **Drought monitoring & management**
- Rural development & poverty alleviation programmes
- **Efficient management of drought** - depend on the organizational structure & policies of the State

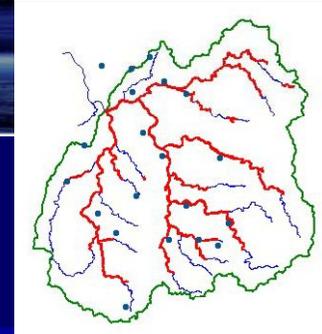
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- <http://drought.unl.edu/whatis/what.htm>
- National Disaster Management Guidelines – Management of Drought – NDMA, Gov. India, Delhi, 2010; [www.ndma.gov.in](http://www.ndma.gov.in)

## Tutorials - Question!?.

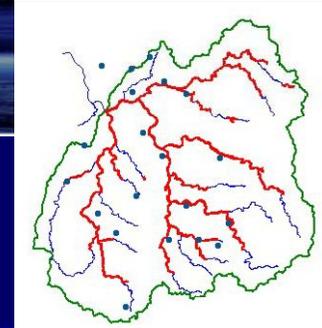
- Critically study the Prevention, Preparedness & Mitigation for drought management as suggested by National Disaster Management Guidelines ([www.ndma.gov.in](http://www.ndma.gov.in))
- Study the necessity of capacity development, relief and responses for drought management (Ref: National Disaster Management Guidelines – Management of Drought – NDMA, Gov. India, Delhi, 2010; [www.ndma.gov.in](http://www.ndma.gov.in))





## Self Evaluation - Questions!.

- Illustrate components of drought mitigation plans.
- Describe necessity of drought monitoring & early warning.
- Differentiate between structural & nonstructural mitigation measures
- Illustrate groundwater dams & its role in drought mitigation
- What are the classification of mitigation actions according to impact sectors
- What are the challenges of drought monitoring?



## Assignment- Questions?.

- What are the important drought mitigation strategies?
- Compare various monitoring & early warning systems used in different countries.
- Discuss drought mitigation & protection.
- Discuss technology for drought reductions.
- What are the categories of mitigation strategies.
- Comment on drought management & mitigation measures.

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# THANK YOU

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