NATURAL HAZARDS - CAUSES, DISTRIBUTION PATTERN, CONSEQUENCE, AND MITIGATION MEASURES

DROUGHT

DROUGHT

- In the last one decade, it has been observed that monsoon rains are deviating very much from its predictions and the region which never experiences acute drought comes under this natural calamity of drought.
- In rainfed areas, drylands are more prone to drought which is found from north to south and in western part of the country.
- About 28% of agricultural land is drought prone and as such suffers from critical water shortages. As uncertainties swing in the onset, continuity, and withdrawal pattern of monsoon make crop production a risky preposition.
- The drought prone areas are low in agricultural productivity and also low in overall economic growth. Poor people in these regions are highly vulnerable to a number of risks due to their low and fluctuating income, high indebtedness and poor human development (NAAS, 2011).
- Helping the poor to come out of vulnerability and poverty and integrating the drought–prone areas into the mainstream of development is a serious challenge faced by policy makers at present.22

Only for your information

What does drought mean?

In simple terms, a drought is a period when rainfall is less than what we consider as normal or expected and there is not enough water to meet the demands of human activities and the environment. However, not all droughts cause problems or become crises. It all depends where and when they occur.

Drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. What is most important is the impact that drought has on people, industry, agriculture, and the environment. It is the shortage of water for all these uses that leads to problems and if they not addressed, they eventually become crises. Defining drought is therefore difficult -

Conceptual definition of drought

- DROUGHT IS A SITUATION OF SIGNIFICANT WATER SHORTAGE RESULTING IN EXTENSIVE DAMAGE TO CROPS, LOSS OF YIELD. ONSET AND END OF DROUGHT IS DIFFICULT TO DETERMINE.
- DROUGHT MAY BE DUE TO INSUFFICIENT RAINFALL OR INCREASE IN WATER DEMAND.
- DROUGHT EFFECTS POPULATION SPREAD OVER LARGER AREAS AND LONGER PERIOD OF TIME
- DIFFICULT TO MEASURE THE SOCIETAL IMPACTS

floods and droughts are in fact normal and recurring natural hazards. They are just part of the natural cycle of weather events and have always been with us throughout history. People are more aware of floods than droughts as they are highly visible. Intense and prolonged rainfall increases runoff and swells rivers causing banks to overflow with immediate and devastating impacts on people's lives, the economy, and the environment. Droughts occur when there is a lack of rainfall and are much less visible, at least initially. However, they too can devastate economies, society, and the environment and their impact can last long after rainfall returns to normal.

- Drought is the normal, recurrent feature of climate. Drought are not like any other crises - because many a times, it is not predictable and the onset of it is also not recognized. Usually, whenever a disaster like flood or earthquake hits, it is very apparent and visible. Drought however has a slow onset. Several weeks, months or years usually pass by before people realize that a drought has occurred. The commencement and the conclusion of drought is unknown. The beginning and end of a drought is usually ambiguous - we become aware of the drought in the middle of it happening.

- It is recognized from its consequences when it is well settled. It is visible when the water supply exceeds the demand of water in large amount and then consequences start being visible, like destruction of vegetation, very low water levels in lakes, ponds, loss of wetlands, lack of food and drinking water, destruction of fish and wildlife etc. This is because drought is a situation of extended period of significant water shortage through either less rainfall, increased demands, or other environmental factors. In the beginning, drought can look like a delayed rainfall cycle, or a short period of water shortage. It is only when the period of water scarcity is prolonged or the water shortage increases significantly that we recognize a drought.

- Predicting drought includes monitoring of rainfall, temperature data, availability of groundwater etc. These data values change slowly and thus substantial changes in these data show over a period of time. Which is why the onset of drought is recognized only when the drought is settled in.

- Even though drought is a normal and recurring natural hazard, it varies in intensity and appearance from region to region. Drought is a comparative water shortage and is measured relative to the regular water supply in that region so there's a lack of set quantatative measurements for predicting it. This is unlike other crisis like earthquakes which can be measured through Richter scale etc.

- Though drought is basically caused by deficit rainfall, which is a meteorological phenomenon, it manifests into different spheres because of various vulnerability factors associated with them. Some of these factors are human induced.
- Though drought is a natural disaster, its effects are made worst in developing countries by over population, over grazing, deforestation, soil erosion, excessive use of ground and surface water for growing crops, loss of biodiversity.

❑ Globally droughts cause US$6-8 billion of damage every year and affect more people than any other hazard. Droughts affect both developing and developed countries where impacts on industry and economic growth can be costly.

❑ Many people associate the occurrence of drought with most of Africa, India, China, the Great Plains of North America, and Australia;

❑ California, in the US, experienced a severe 5-year drought from 2013. In 2015, Sao Paulo, a mega-city in Brazil experienced its worst drought for more than 80 years – a paradox in a country that has one of the world's largest freshwater rivers.

❑ The UK, with a reputation for grey skies and rain, experienced a severe two-year drought in 2011-2012 with major impacts on public water supply, agriculture, and the aquatic environment.

❑ Europe also has a humid climate but is increasingly prone to drought. Central and Eastern Europe (CEE) experienced a severe drought in 2015 that provided the catalyst for engaging in serious drought management planning.

Only for your information

Agricultural

Meteorological

Hydrological

Socioeconomic

Defining Drought

Meteorological drought: Meteorological drought is determined by the lack of precipitation and how conditions such as temperature and winds affect the amount of moisture. It is expressed in relation to the average conditions for a region. Meteorological drought is region specific since precipitation is highly variable from region to region. The country as a whole may have a normal monsoon, but different meteorological districts and sub-divisions can have below normal rainfall. The rainfall categories for smaller areas are defined by their deviation from a meteorological area's normal rainfall -

Excess: 20 per cent or more above normal
Normal: 19 per cent above normal - 19 per cent below normal
Deficient: 20 per cent below normal - 59 per cent below normal
Scanty: 60 per cent or more below normal

Agricultural drought: Agricultural drought links the characteristics of meteorological drought to agriculture or landscapes. This type of drought focuses on precipitation shortages, evaporative demand, and soil moisture deficits. This type of drought is also dependent upon plant type, stage of growth, and soil properties.

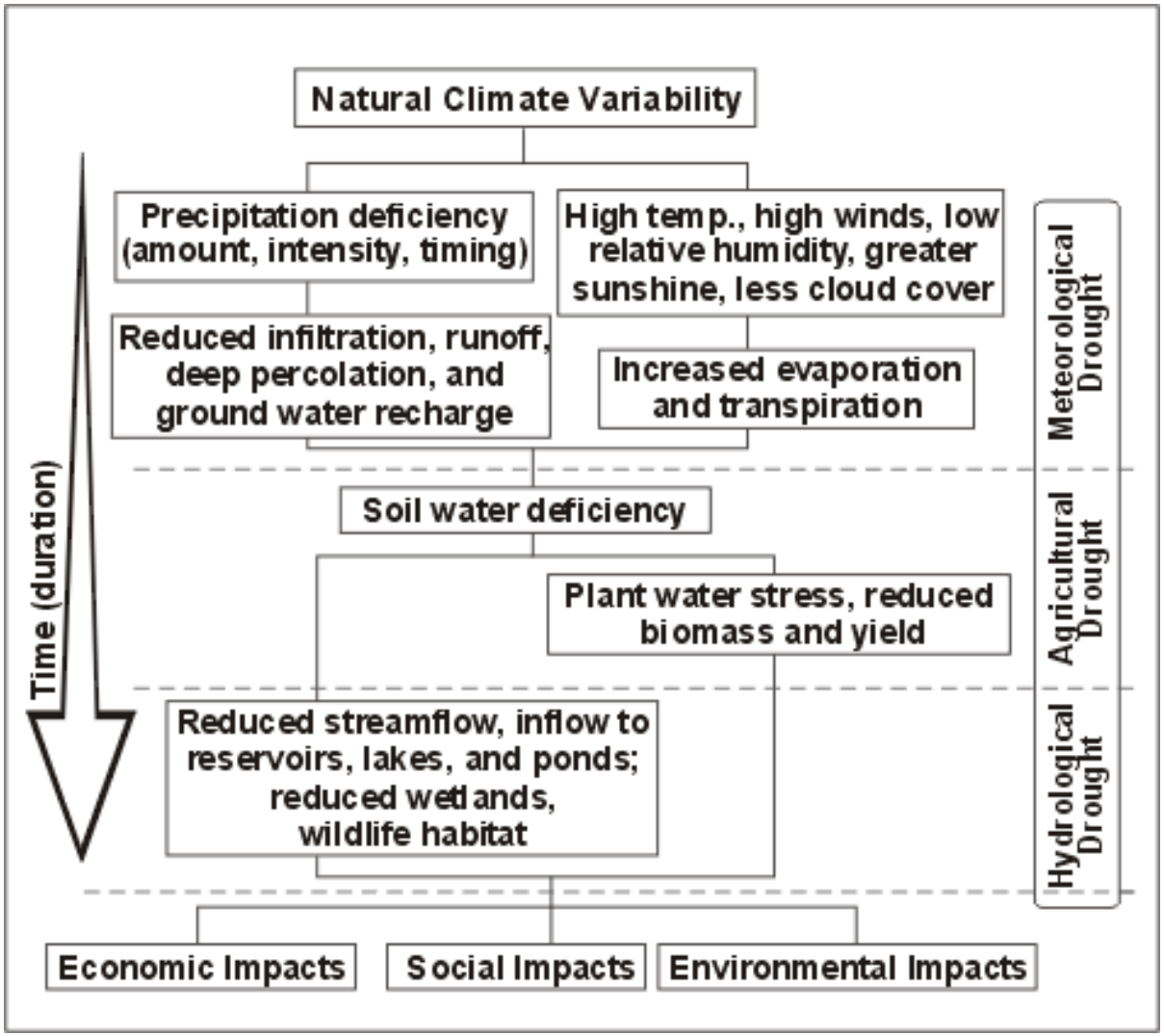
Hydrological drought: Hydrological drought is associated with the effects of rain and snow shortfalls on streamflow, reservoir and lake levels, and groundwater. Because it takes longer for precipitation deficiencies to show up in other components of the hydrological system, this type of drought can be out of phase with the other types of drought.

Socio-economic drought: Finally, socioeconomic drought associates the supply and demand of some economic good or service with elements of meteorological, hydrological, and agricultural drought.

For example, the supply of some economic good (e.g., water, hay, hydroelectric power) is weather dependent. Therefore, drought could be defined as occurring when the demand for that good exceeds supply as a result of a weather-related supply shortfall. While people typically think of agricultural products, drought can also affect hydroelectric energy generation, ethanol production, and numerous other items.

Earlier years of all-India drought 1987, 1979, 1972.

- Agricultural drought links various characteristics of meteorological drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration (ET), soil water deficits, and so forth.
- A plant's demand for water is dependent on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.
- For example, deficient subsoil moisture in an early growth stage will have little impact on final crop yield if topsoil moisture is sufficient to meet early growth requirements.
- However, if the deficiency of subsoil moisture continues, a substantial yield loss may result.
- The impacts slowly spread into social fabric as the availability of drinking water diminishes, reduction in energy production, ground water depletion, food shortage, health reduction and loss of life, increased poverty, reduced quality of life and social unrest leading to migration



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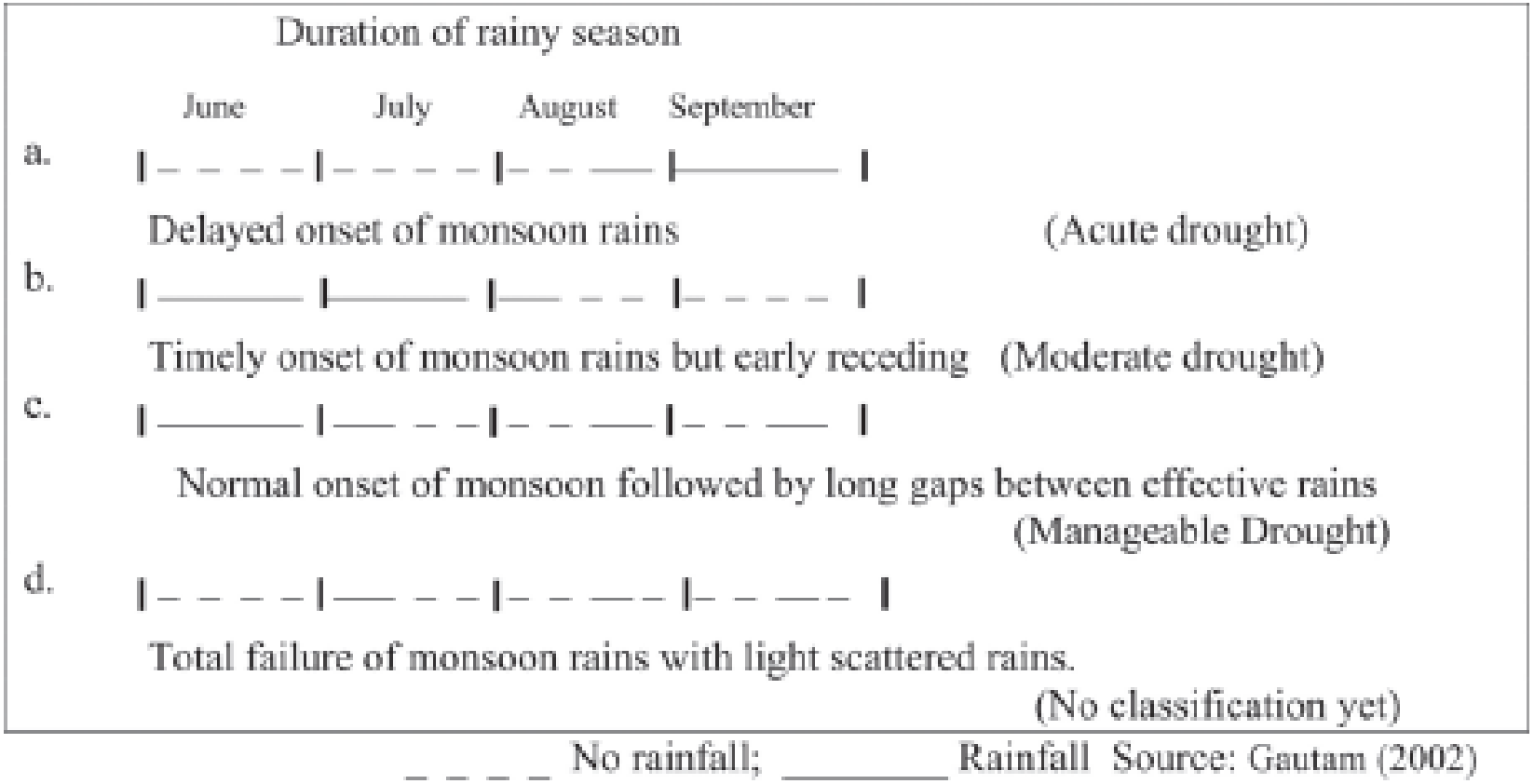
Probable abnormal monsoon conditions in India



Only for your information

- While India has strong drought assessment capabilities, there is need to enhance capacity for early warning system (EWS) and impact monitoring, particularly in the light of climate change impacts, which can further compound the challenge of drought monitoring for early warnings because of wide variability in rainfall pattern even at local levels.
- Lack of adequate drought monitoring systems and the capacity to respond via appropriate political, institutional, and technological frameworks, inhibit the development of integrated drought management plans or early warning systems.
- There is need of top-down approach to provide national real-time drought monitoring and seasonal forecasting, and a bottom-up approach that builds upon existing regional and local systems to provide national coverage.

Understanding Drought :

1. Monitoring Drought : It is continuous observation of the rainfall situation, availability of water in the reservoirs, lakes, rivers etc and comparing with the existing water needs in various sectors of the society.

- Monitoring activities include the collection and analysis of data, data product development, and the communication of data products to decision makers and other users. Data includes not only physical data related to hazards but also social and biological data that assist in the definition of vulnerability.
- This information is useful in forecasts of agricultural and hydrological drought.
- Monitoring and early warning systems (MEWS), including the use of indices to track current drought conditions and to view them in a historical context.

❑ Tools and Techniques for drought assessment (early warning indicator) : Drought Indices

- ❑ Quantitative assessment of climate conditions
- ❑ Combination of drought indices to give overall picture of what is occurring

Satellite derived drought indicators calculated from satellite-derived surface parameters have been widely used to study droughts. Remote sensing and GIS technique is increasingly being regarded as a useful drought detection technique. Some tools and technique for analysing drought using GIS….

- ❑ Standardized Precipitation Index (SPI)
- ❑ Normalized Difference Vegetation Index (NDVI)
- ❑ India Meteorological Department Method (IMD) and
- ❑ Moisture Adequacy Index (MAI)

a). Standardised Precipitation Index (SPI)

Most indicators use meteorological information such as the popular and widely used Standardised Precipitation Index (SPI). This is simple to use but is limited to meteorological drought. It is not so useful for forecasting agricultural droughts, which requires a link between the weather conditions and crops being grown. The SPI can be used to monitor conditions on a variety of time scales. This temporal flexibility allows the SPI to be useful in both short-term agricultural and long-term hydrological applications. Mathematically, SPI is calculated based on the following equatic

$$SPI = \frac{(Xi - Xm)}{\sigma}$$

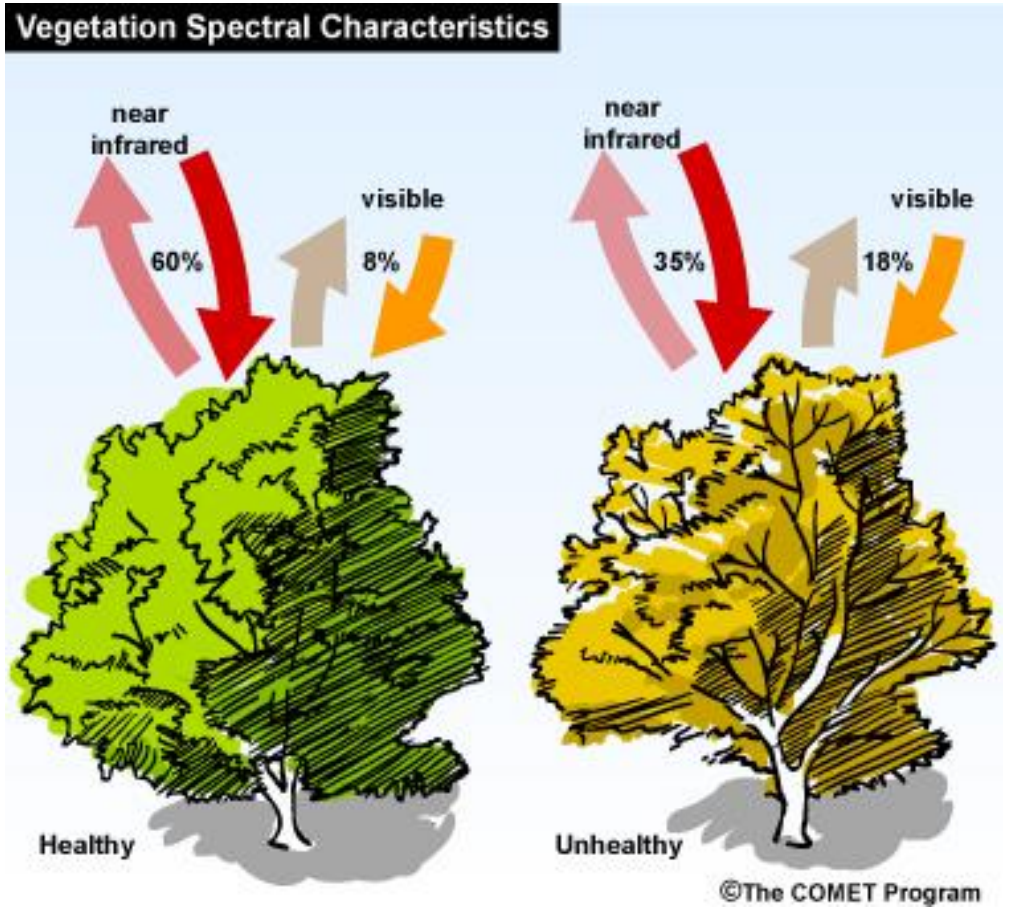
where, X_i is monthly rainfall record of the station;
X_m is rainfall mean; and
σ is the standard deviation

- Less than -2.00 Extreme drought
- -1.50 to -1.99 Severe drought
- -1.00 to -1.49 Moderate drought
- -0.99 to -0.00 Mild drought

SPI classification	
2.0 or more	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2.0 and less	Extremely dry

b) Normalized Difference Vegetation Index (NDVI) :

- The greenness of the products are based on the NDVI.
- NDVI is calculated as a difference between visible (in the red range of the spectrum) and near-infrared light reflected by vegetation.
- Healthy vegetation absorbs most of the visible light and reflects a large portion of the near-infrared light that it receives.
- In contrast, unhealthy and/or sparse vegetated surfaces reflect more visible light and less near-infrared light. Note that the data varies for real vegetation.
- According to this formula, the density of vegetation (NDVI) at a certain point of the image is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities.



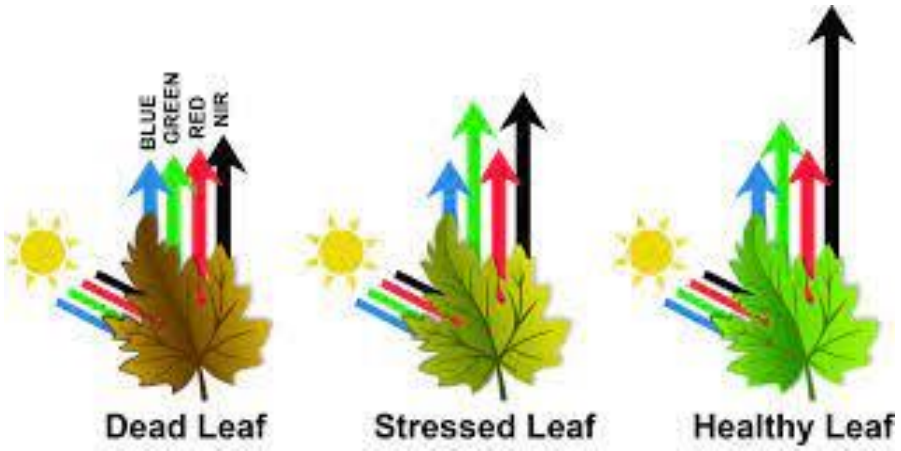
$$NDVI = \frac{NIR - RED}{NIR + RED}$$

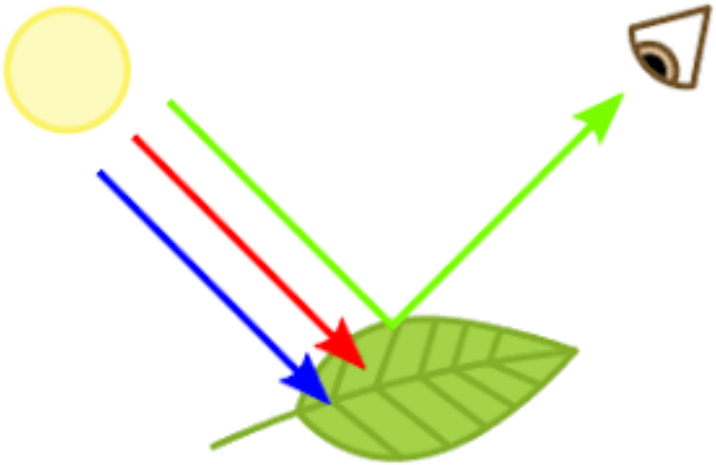
NIR - reflection in the near-infrared spectrum
RED - reflection in the red range of the spectrum

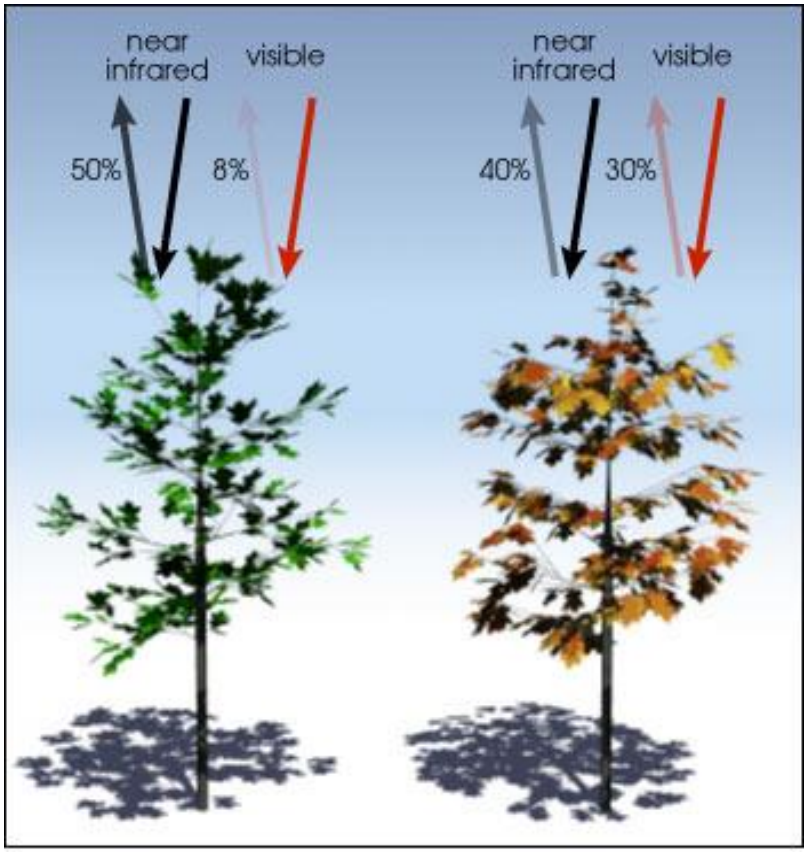
This index defines values from -1.0 to 1.0, basically representing greens, where

- negative values are mainly formed from clouds, water and snow, and
- values close to zero (0.1 or less) are primarily formed from rocks and bare soil.
- Moderate values (from 0.2 to 0.3) represent shrubs and meadows, while large values (from 0.6 to 0.8) indicate temperate and tropical forests.
- Crop Monitoring successfully utilizes this scale to show farmers which parts of their fields have dense, moderate, or sparse vegetation at any given moment.

- NDVI is a measure of the state of plant health based on how the plant reflects light at certain frequencies (some waves are absorbed and others are reflected).
- Chlorophyll (a health indicator) strongly absorbs blue (400-500 nm, chlorophyll a) and red light (600-700nm, chlorophyll b), reflects green and NIR, and thus the green appearance of healthy vegetation.
- When the plant becomes dehydrated, sick, afflicted with disease, etc., the spongy layer deteriorates, and the plant absorbs more of the near-infrared light, rather than reflecting it.
- Thus, observing how NIR changes compared to red light provides an accurate indication of the presence of chlorophyll, which correlates with plant health.







$$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72$$

$$\frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$$

Impact of Drought :

1) Social: Social impacts of drought are ways that drought affects people's health and safety

- Food shortage
- Loss of human life from food shortages, heat, suicides
- Social unrest
- Mental and physical stress
- Water user conflicts
- Political conflicts

2) Examples of environmental impacts include:

- Lower water levels in reservoirs, lakes, and ponds
- Loss of wetlands
- Losses or destruction of fish and wildlife habitat
- Lack of food and drinking water for wild animals
- Increased stress on endangered species or even extinction
- More wildfires

Legal and Institutional Framework

While the central government plays the role of a facilitator, the primary responsibility of managing drought (or any other natural calamity) is that of the respective State government.

With the enactment of the Disaster Management Act in 2005, the National Disaster Management Authority (NDMA) was set up as the apex body for Disaster Management in India, with the Prime Minister as its Chairman. Further, Disaster Management Authorities at the State and District Levels are headed by the Chief Ministers and Collectors/*Zilla Parishad* Chairmen respectively.

The National Disaster Response Fund (NDRF) and State Disaster Response Fund (SDRF), constituted under 2005 Disaster Management Act, provide immediate drought relief to the affected people.

2. DROUGHT PREPAREDNESS :

- PREPAREDNESS REFERS TO PRE-DISASTER ACTIVITIES DESIGNED TO INCREASE THE LEVEL OF READINESS OR IMPROVE OPERATIONAL AND INSTITUTIONAL CAPABILITIES FOR RESPONDING TO AN EMERGENCY (E.G., EARLY WARNING SYSTEMS, OPERATIONAL PLANS).
- FOR DROUGHT, CONTINGENCY PLANS ARE USEFUL FOR DENOTING PROGRAMMATIC RESPONSIBILITIES; IMPROVING INFORMATION FOLLOW ON SEVERITY, IMPACTS, AND POLICIES BETWEEN AND WITHIN LEVELS OF GOVERNMENT; AND COORDINATION BETWEEN LEVELS OF GOVERNMENT.
- 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.

3. Drought planning: the basic goal of drought planning is to improve the effectiveness of preparedness and response efforts by enhancing monitoring, mitigation and response measures.

iv. Planning would help in effective coordination among state and national agencies in dealing with the drought. Components of drought plan include establishing drought taskforce which is a team of specialists who can advise the government in taking decision to deal with drought situation, establishing coordination mechanism among various agencies which deal with the droughts, providing crop insurance schemes to the farmers to cope with the drought related crop losses, and public awareness generation.

4. DROUGHT MITIGATION

- THE COMMENCEMENT AND CONCLUSION OF DROUGHT IS UNKNOWN. DROUGHT IS REALIZED FROM ITS CONSEQUENCES WHEN IT IS WELL SETTLED.
- THEREFORE, THE DROUGHT MITIGATION PROGRAMMES FALL IN 3 CATEGORIES AS SHORT TERM MEASURES, MEDIUM TERM MEASURES AND LONG TERM STRATEGIES.
- A first step in mitigation is the identification of the impacts associated with previous droughts and an assessment of whether these impacts (and others) are likely to be associated with future drought events. From this point, specific actions can be identified to reduce the impacts of future drought events.

SHORT TERM MEASURES

1. TRANSPOTATION OF DRINKING WATER BY RAIL AND ROAD TO AFFECTED AREAS
2. TUBE WELL CONSTRUCTION ON LARGE SCALE

MEDIUM TERM MEASURES

1. RAIN WATER HARVESTING AND WATERSHED MANAGEMENT:
2. ARTIFICIAL RECHARGE OF GROUND WATER
3. PLANING FOR BETTER SCIENTIFIC UTILIZATIOOF AVAILABLE WATER
4. DRY LAND FARMING TECHNIQUES AND INTRODUCTION OF WATRE SAVING OF CROPS.
5. ADOPTING MODERN IRRIGATION TECHNIQUES

LONG TERM STRATEGY

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. INTER BASIN TRANSFER OF WATER

DROUGHT MITIGATION : (i) Structural Measures

As per the Manual for Drought Management (2009), the State Governments besides Panchayati Raj Institutions need to actively involve non-governmental Organizations (NGOs) and Civil Society Organizations (CSOs) in effectively managing droughts through watershed-management projects, change of cultivation methods, use of modern deep irrigation methods etc.).

a) Artificial recharging of ground water, watershed programmes in privately owned small/marginal farms, laying of pipes/channels for exclusive transportation of water to dry areas;

b) Implementation of traditional rainwater harvesting method, construction of canals for transportation of water from surplus to non-surplus areas, establishment of cost-effective drip /sprinkle irrigation practices etc.

c) Construction of watershed structures at the right place where water recharge will be used for life saving irrigation at critical stages of crop growth and during drought situations.

d) Construction of “Community Ponds” through Panchayati Raj Institutions (PRI) and maintenance by levying user charges.

Water supply augmentation and conservation through rainwater harvesting in houses and farmers’ fields increases the content of water available. Water harvesting by either allowing the runoff water from all the fields to a common point (e.g. Farm ponds) or allowing it to infiltrate into the soil where it has fallen (in situ) (e.g. contour bunds, contour cultivation, raised bed planting etc) helps increase water availability for sustained agricultural production.

There are two major techniques of rainwater harvesting - Surface runoff harvesting and groundwater recharge :

- Surface runoff harvesting is most suitable in urban areas.
- In this method, rainwater flows away as surface runoff and can be stored for future use.
- Surface water can be stored by diverting the flow of small creeks and streams into reservoirs on the surface or underground. It can provide water for farming, for cattle and also for general domestic use.
- Rooftop rainwater/storm runoff can be harvested in urban areas through:
  • Recharge Pit, • Recharge Trench, • Tubewell, • Recharge Well

Recharge to groundwater:

For conservation of water Small dam/Check dam, Khet Talawadi, GULLY PLUGGING can be constructed. The surplus rainwater can thus be used to recharge groundwater aquifer through the above mentioned artificial recharge technique.

DROUGHT PREPARENESS & MITIGATION

Non-Structural Mitigation Measures: Enhancing management skills

(ii) Non-structural Mitigation, generally involves a reduction in the likelihood or consequence of risk through modifications in human behavior or natural processes, without requiring the use of engineered structures. They tend to be less costly and fairly easy for communities with few financial or technological resources to implement.

(a) Hazard-zoning by the State Governments (identification of drought prone areas) using 'V*ulnerability Mapping'* (e.g. real time display of aridity maps, soil moisture stress maps, NDVI Maps etc. for drought) and '*Risk Assessment Analysis'* (e.g. standardization of risk assessment analysis in quantitative and qualitative terms as per the Manual for Drought Management).

(b) Preparation of inventory of resources by the State governments to meet likely emergency requirements of inputs (seeds, fertilizers etc.) and energy (power & diesel for pump sets), tankers & wagons (for drinking water movement), fodder availability (planning for movement from surplus areas including those from forest areas), availability of food grains and advance allocation plan, agricultural credit, planning for risk insurance etc.

c) Community Awareness and Education Programs:

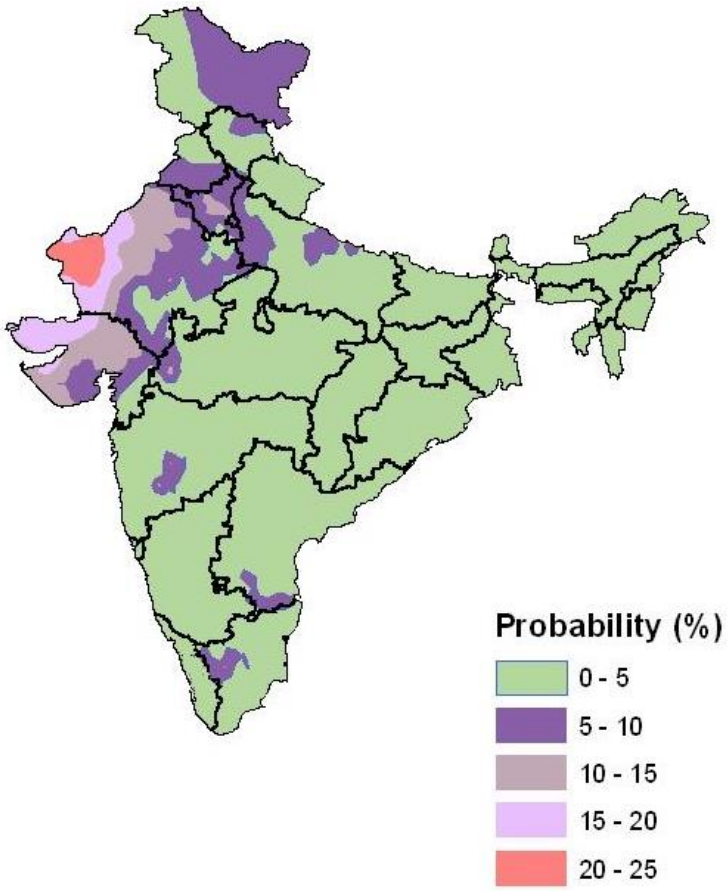
The public is most able to protect themselves from the effects of a hazard if they are first informed that the hazard exists, and then educated about what they can do to limit their risk.

Vulnerability assessment considers the potential impact of loss caused by a disaster as well as the vulnerability of the drought area. As far as India is concerned, it is vulnerable, in varying degrees. Droughts adversely impacts livelihood and economies of a large section of population in the rain-fed, arid and semi-arid regions. According to the National Remote Sensing Centre (2008), about two thirds of the geographic area of India receives low rainfall (less than 1000 mm), which is also characterized by uneven and erratic distributions. Out of net sown area of 140 million hectares, about 68% is reported to be vulnerable to drought conditions and about 50% of such vulnerable area is classified as 'severe', where frequency of drought is almost regular.

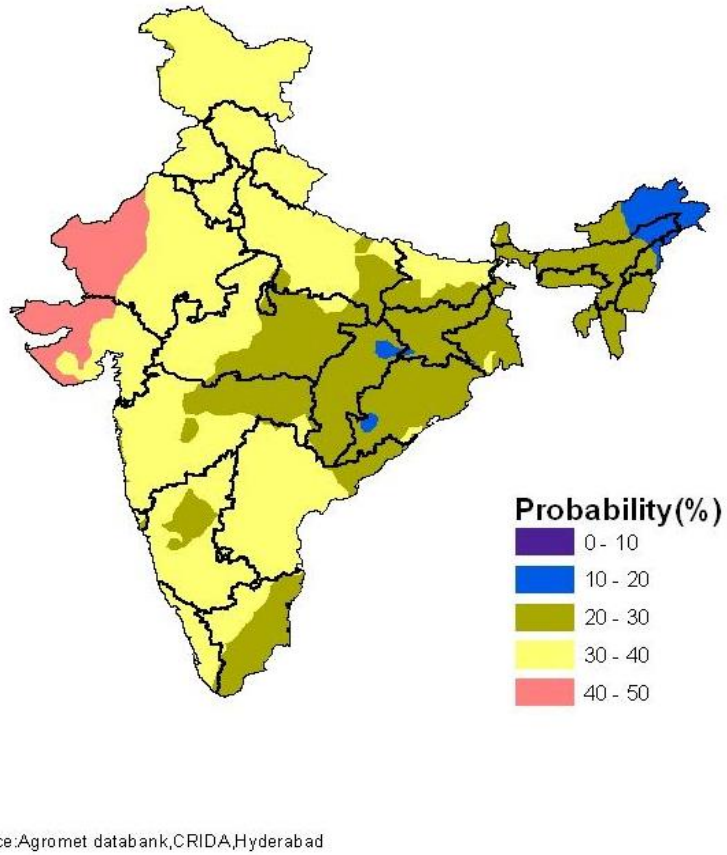
Vulnerability and impact assessments inform the need for actions and in turn the actions feedback to reduce vulnerability and impacts. (MEWS) provides information to reduce risk and in turn, feedback from actions taken can help improve monitoring and communications services.

DISASTER RESPONSE:

This is about taking actions to reduce risk and improve responses to drought emergencies as and when they occur. Response includes improved drought monitoring, better water and crop management, augmentation of water supplies with groundwater, increased public awareness and education, intensified watershed and local planning, reduction in water demand, and water conservation.



Probability of occurrence of severe droughts



Probability of drought occurrence

Flood Hazards in India

- Floods being a natural phenomena, total elimination or control - not possible nor economically viable.

- Flood management aims at providing reasonable protection against damage at reasonable economic costs.

Floods are local and short-lived events that happen suddenly and mostly without any warning. Most floods occur due to intense storms that produce higher levels of runoff than the area can store, or a river/stream can carry within its normal capacity. Rivers could also flood its surroundings in the event of dams failing, due to landslide or ice blocking the course of the river, as well as when snow melts rapidly. ***No need to memorize line by line***

Due to the unique topography and climatic characteristics of the Indian Sub-continent, many of its parts are susceptible to different types of disasters. It is estimated that over four crore hectares of land is vulnerable to floods, and about 54 per cent to earthquakes. Such disasters lead to enormous economic losses, demanding additional revenues. There is also the probability of reduced revenues from affected regions. The unexpected and unplanned budgetary allocation towards disaster recovery could hamper developmental activities and result in various unmet, planned developmental targets. Flood is one of the most common natural disasters that need to be coped.

Causes of Flood

- Excessive rainfall in river catchments or concentration of runoff from the tributaries and river carrying flows in excess of their capacities.
- Backing of water in tributaries at their confluence with the main river.
- Synchronization of flood peaks of the main rivers and tributaries.
- Landslides causing obstruction to flow and change in the river course.
- Poor natural drainage.
- Cyclone and very intense rainfall.

Types of Flood

River Floods

- Riverine floods are caused by melting of snow and precipitation over large areas.
- They take place in rivers. Floods in large rivers take hours to days.
- The ground conditions effects the runoff.

Coastal Floods

- Coastal floods are caused by tides, storms, tropical cyclones, or tsunamis.
- They happen in the ocean and effects the general public and maritime interests along the coastline.

Urban Floods

- Urban floods are when the land is turned from fields or woods into roads and parking lots. Since this happens it can't absorb the rainfall.
- During the urban floods all the streets become rivers and basements become full of water, they are death traps.

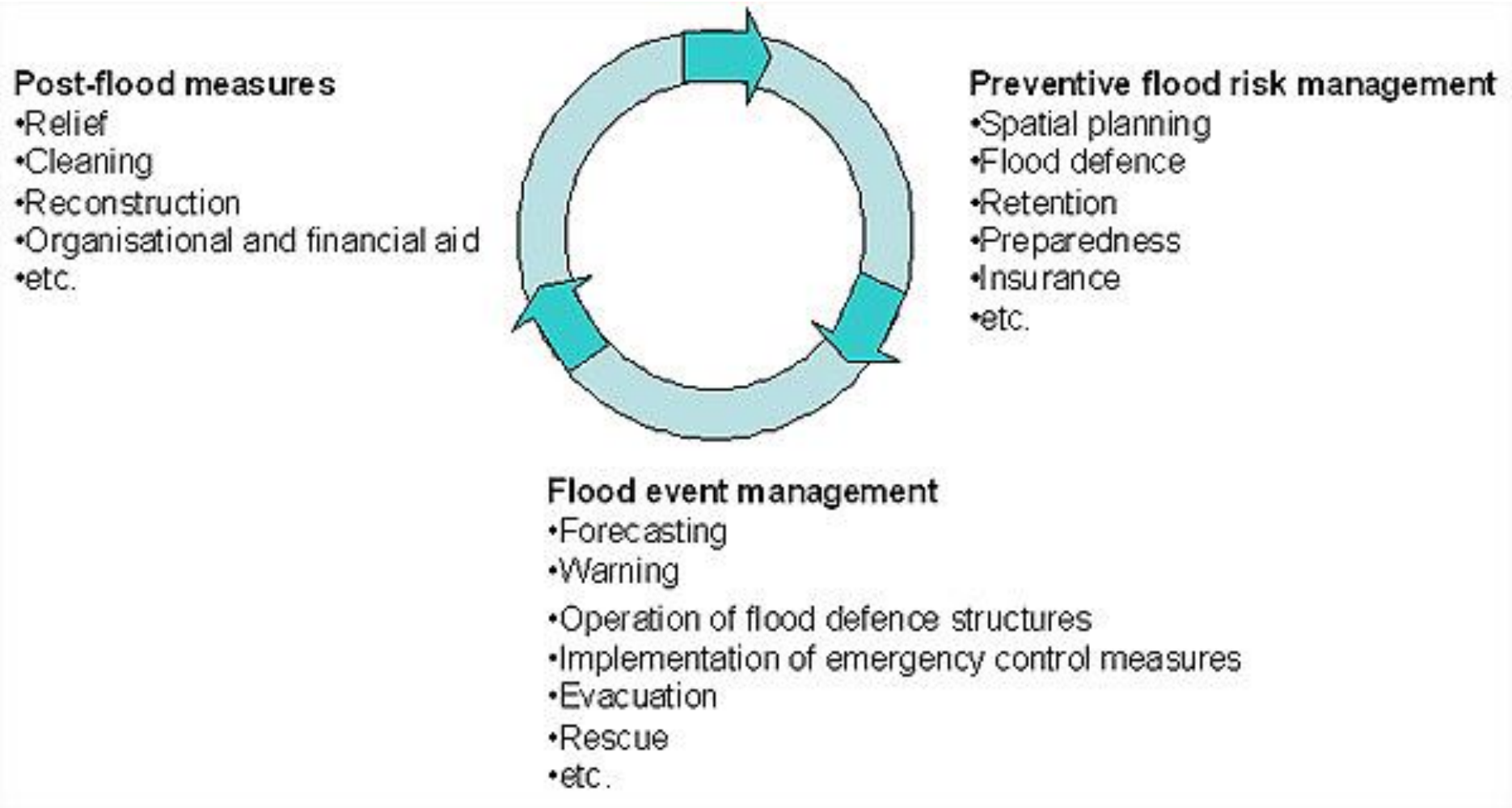
Flash floods

- Flash floods happen in a short time, they have a great volume of water, and are local floods.
- The runoff of intense rain results in high flood waves.
- It usually happens in desert areas and mountain regions.
- They are a threat in steep land, high runoff rates, thunderstorms, and narrow streams.

Lakeshore floods

- Lakeshore floods affect the general public as well as some areas of the Great Lakes.
- These floods extend from the beaches to rivers that flow into lakes.

The role of flood event management within the cycle of flood risk management activities is shown in the figure below.



An ideal strategy to tackle flood is to proactively manage them. This requires the identification of the risk, development of strategies to reduce the risk, and creation and implementation of policies and programmes. This would help in evaluation of all the schemes so that the overall risks are reduced. The relevant steps in this direction include **assessing the potential** of the hazard to occur, **conducting vulnerability analysis** to have an understanding about the consequences in case an event occurs in certain magnitude and frequency. Thereafter, various **mitigation measures** can be decided and their ability for reducing risk be assessed.

No need to memorize line by line

Experiences show that one of the most common reasons for aggravation of flood problem is illegal encroachments into the flood plains over the past few years. To mitigate this problem there is the need to take various **structural** and **non-structural** measures. Structural measures for flood management are physical in nature, and are aimed at preventing flood waters from reaching residential or other areas. Here we '*keep water away from people*'. Non-structural measures are involved in '*keeping people away from flood waters*'.

METHOD OF FLOOD CONTROL

Structural measures

1. Embankment
2. Watershed management for flood control
3. Levees
4. Flood walls
5. Construction of cut-off
6. Afforestation

Non-structural measures

1. flood forecasting,
2. flood plain zoning,
3. flood proofing,
4. disaster preparedness etc.

Embankment - Keeping the flood away from the people means structural mitigation. The most popular and prominent structural measure to mitigate floods is construction of embankments. An artificial bank is built along the coast to protect the surrounding land from inundation. It runs parallel to the river banks and thus restricts the flow of water reaching the land outside the river. The banks are raised such that the river water is kept within the boundaries on its existing course, and not allowed to overflow and flood the areas. As embankments are constructed with soil and other easily-available materials, they're inexpensive and easy to construct. Concrete and mason are used in construction only when land is really expensive in an area. While protecting the banks from flooding, embankments can also host roads across their lengths and serve as communication links between neighbouring areas. Therefore, they succeed in keeping the flood away from people.

(a) *Construction of embankments:* One of the most important and popular structural measures for control of flood is construction of embankments. Embankments, including ring bunds and town-protection works, are one of the most popular structural measures for flood protection. Embankment restricts the flow of river within its existing course and prevents it from overflowing the banks. Embankments are normally constructed with materials that are easily available in the nearby areas. However, in areas where land is very expensive, concrete or masonry floodwalls are constructed to serve as embankments. Embankments have traditionally provided an array of positive benefits through ensuring protection against floods and river spills. Embankments on which roads have been built have provided useful connection and communication links.

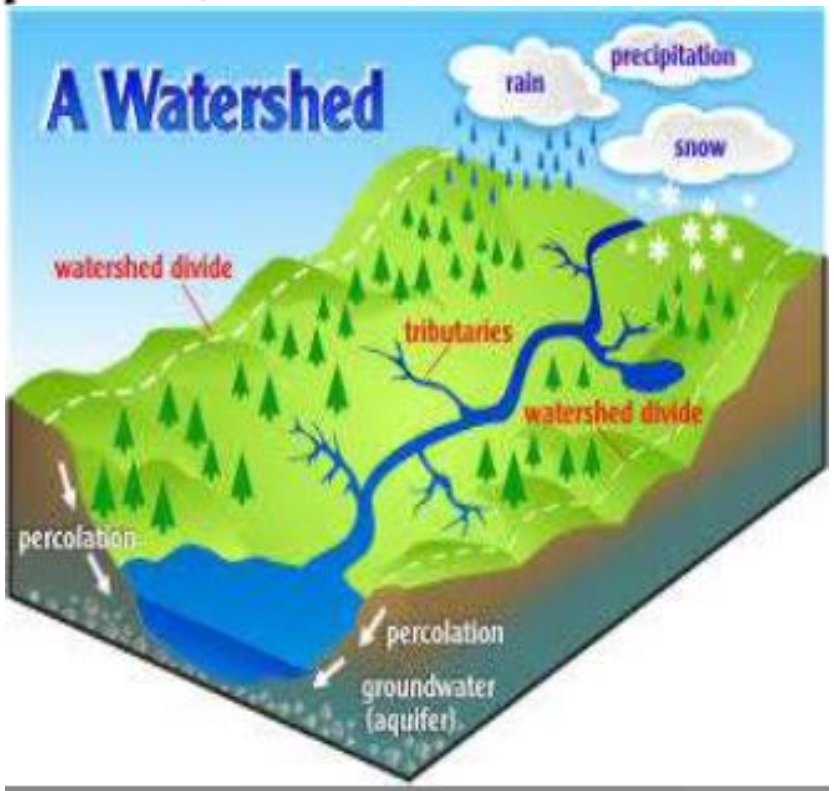
Levees –

- Levees represent one method of reducing the impacts of flooding on a community or a region.
- Levees keep the floodwaters away from the area behind the levee until the point at which the levee is overtopped or fails and the area behind the levees is inundated and the people and property are affected.

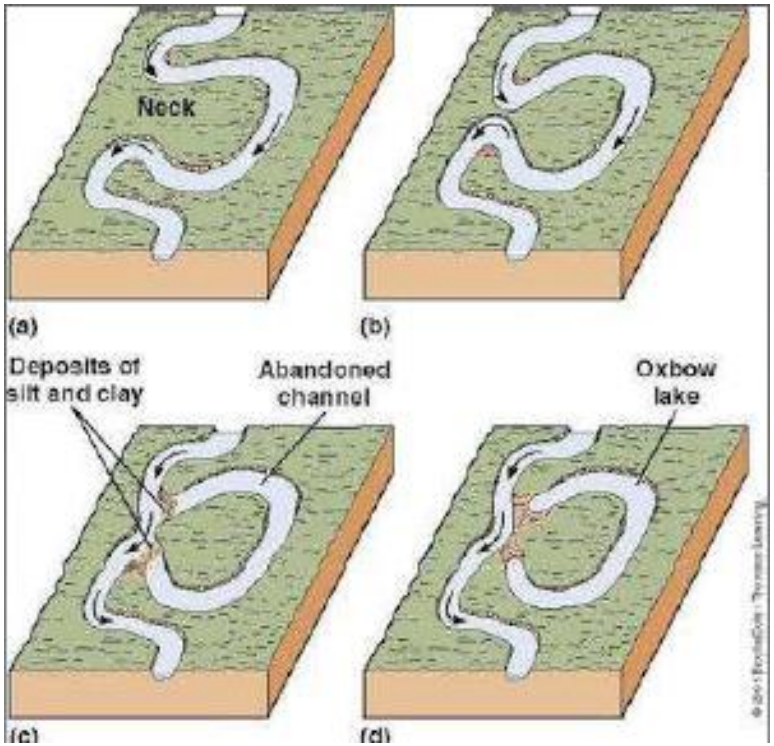
Flood walls

- Flood wall is usually of masonry or concrete.
- Usually constructed in which enough land is not available for levees.
- If land is costly or limited, it is more economical to construct flood wall.
- Constructed on river bank.

(b) *Watershed management:* Alluvial Rivers are usually prone to erosion and silting at various locations. There is a natural phenomenon of loss of land at one location and gain at some other due to erosion and silting. The general tendency is of a progressive meandering downstream. There is the possibility of bank erosions upstream, which should be taken care of thorough protection of the banks. Desilting or dredging of rivers where the rivers emerge from the hills into the plains, at convex bends and near their outfall into another river or lake or sea, will help in devouring the river of silt. This will help in increasing the depth of the rivers, thereby reducing the possibility of floods. This step is however yet to gain traction in India.



Construction of cut-offs



- During heavy rainfall when large flood discharge approaches the sharp bend of the river, it overflows its bank and submerges the surrounding area.
- So cut-off constructed to reduce travel time and water flow with high velocity along a straight path.

AFFORESTATION

- Afforestation can occur where trees are planted near to the river. This means greater interception of rainwater and lower river discharge.
- This is a relatively low cost option, which enhances the environmental quality of the drainage basin.
- Trees hold the shores and keep the river bed in place and in shape. This helps the water flush away reducing the length of the flood.
- They serve as a "filter" for floating objects (such as rocks, trees and debries), that are a major threat during floods because they crush on house and infrastructure.

Flood forecasting and warning

- Flood forecasting enables forewarning as to when the river is going to use its flood plain, to what extent and for how long.
- As per strategy of laying more emphasis on non-structural measures, Central Water Commission has established a nationwide flood forecasting and warning system.
- With reliable advance information/warning about impending floods, loss of human lives and moveable properties, human miseries can be reduced to a considerable extent.
- People and cattle can be shifted to safer places. Similarly, valuable moveable properties can be removed to safer places beyond area to be inundated.
- Large number of reservoir schemes to harness water resources for irrigation, power etc. were undertaken in the country during various plan periods.

No need to memorize line by line

Flood Forecasting and Warning

❖ **Steps**

- Data collection
- Data transmission
- Data analysis & forecast formulation
- Dissemination of forecast

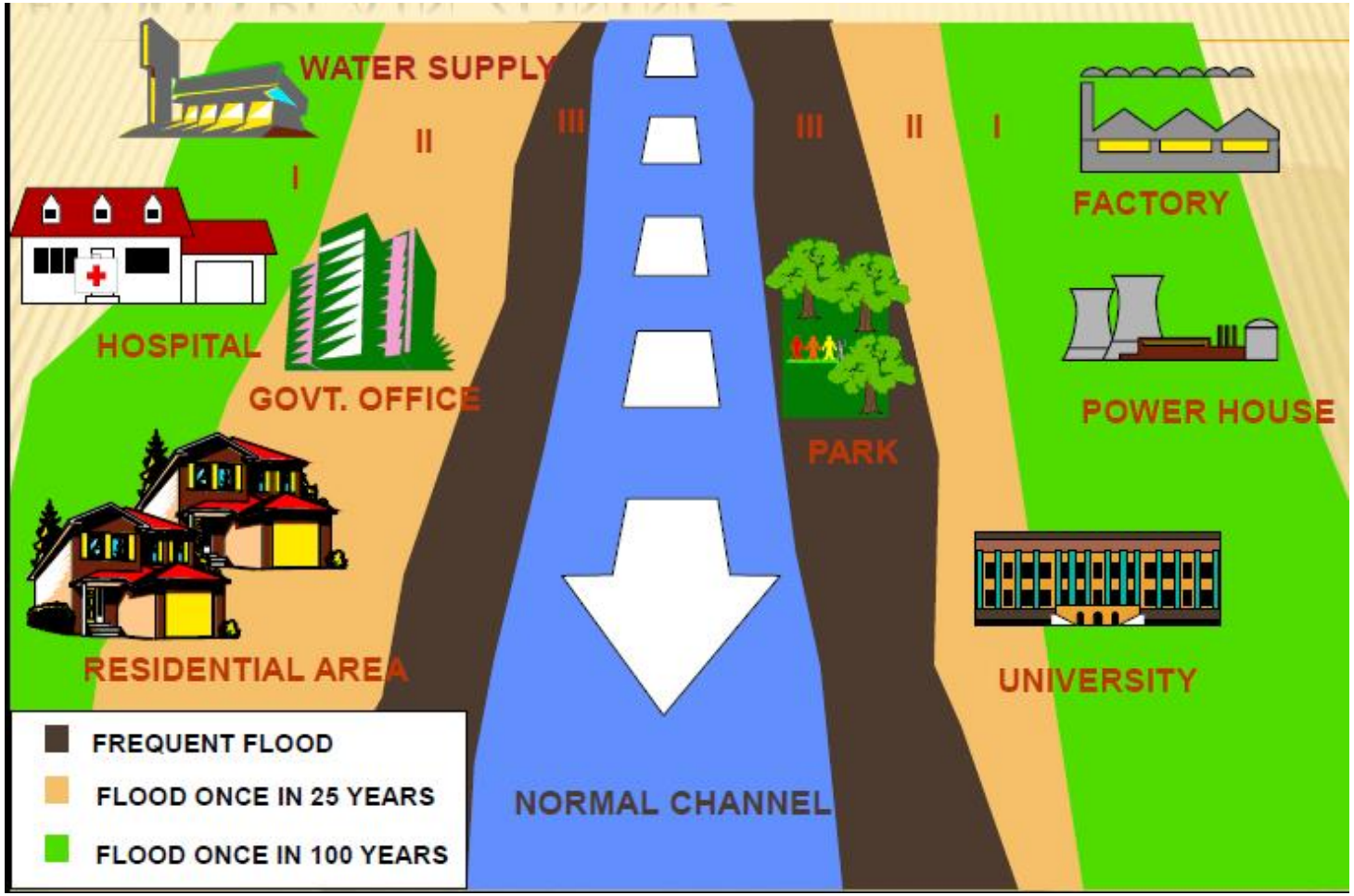
Present flood forecasting network in India

- The flood forecasting system of Central Water Commission (CWC) is presently responsible for issuing flood forecasts at 157 stations of which 132 stations are for river stage forecast and 25 for inflow forecast.
- Chief Engineers, Superintending Engineers and divisional offices are in charge of management of the forecasting work.
- These offices are responsible for hydrological (river water level, river discharge etc) and hydro meteorological (rainfall, other precipitation like snow, hail etc) data collections.
- Forecast about water level in river likely to be attained as a result of flood and volume of inflow to reservoir is issued by concerned officers everyday in the morning.
- The forecasts issued by CWC have been consistently accurate as a result of which the flood forecasting and warning services have rendered immense benefit to the people in the flood prone areas.

No need to memorize line by line

FLOOD PLAIN ZONING

- An important non-structural measure.
- Regulates land use in flood plains to restrict damage by floods.
- Involves demarcation of zones in flood plains compatible with flood risks involved.



ZONE REGULTIONS

- Priority – I

▪ Activity limited to water levels corresponding to 100 years flood frequency and drainage congestion for 50 years rainfall.

- Priority - II

▪ Activity limited to levels corresponding to 25 years flood frequency and drainage congestion for 10 years rainfall frequency.

- Priority - III

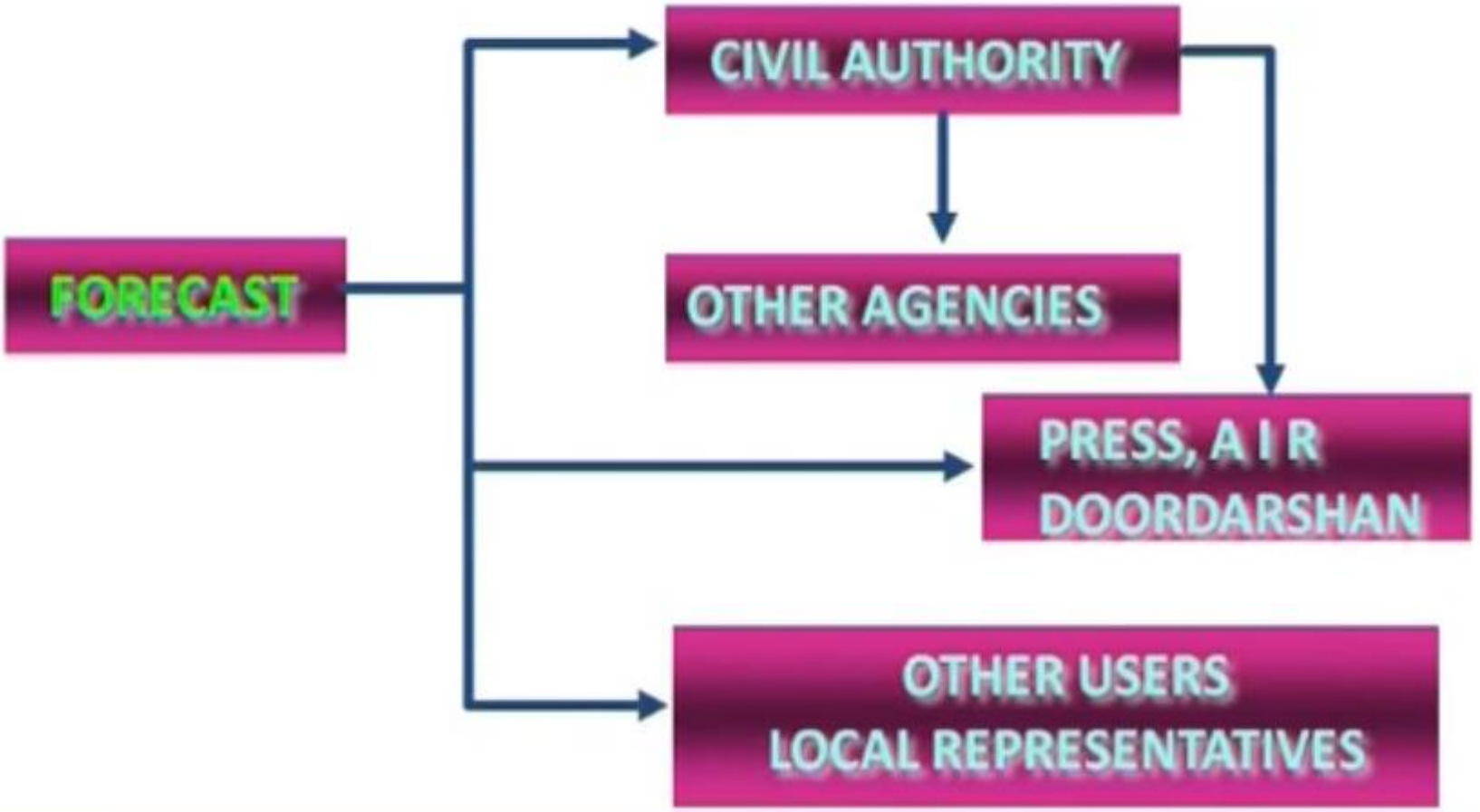
▪ Less economic and community activity in areas vulnerable to frequent floods.

Flood Proofing

- Flood proofing measures help greatly in the mitigation of distress and provide immediate relief to the population in flood prone areas.
- It is essentially a combination of structural change and emergency action, not involving any evacuation.
- The techniques adopted consist of providing raised platforms for flood shelter for men and cattle and raising the public utility installations above flood levels and other facilities to make various essential services flood proof so that the miseries of people can be reduced to minimum even when flooding occurs.

1. **Creating awareness:** Awareness should be created among all medical teams and the community regarding the type of illnesses and other health related problems that can occur as a result of the aftermath of floods. They should also be made aware of the need for hand washing using detergents, use of the toilet for defecation, safe food cooking by disease-free persons, etc.
2. **Evacuation plan:** There should be an appropriate evacuation plan in force. Emergency medical equipment, drugs and trained paramedical staff, etc. should be made available by the State Governments. Ambulance including Heli-ambulances (depending on the topography of the state) should be deployed for evacuating flood casualties.
3. **Essential medical supplies:** All essential medical supplies including drugs, intravenous (IV) fluid, oxygen, dressing materials, antibiotics, vaccines, anti-snake venom and anti-diarrhea drugs must be readily available. The government should also identify medical stores from where large scale purchases of materials can be effected.

➢ Dissemination



A very important step in effective management of disasters is bridging the information gap. Developing an efficient disaster management information system is an important stage in planning for disaster preparedness.

Information can be disseminating in a number of ways. Now a day's information is disseminating by using technology. Some technology is noted below which are used for disseminating information-

- Internet
- GIS and Remote Sensing
- Disaster alert through cell phone
- Satellite Radio Application
- Television
- Radio
- Print media
- International news agencies etc.

Evacuation is generally more important for coastal areas and large river basins where there is more time for action, while rescue is generally more important in smaller river basins, where lead times may only be a few hours, such as flash floods.

Post-flood recovery and rebuilding

- The post-flood recovery and reconstruction phase provides the opportunity to move vulnerable activities away from risk areas and introduce flood-proof infrastructures during rebuilding.
- Vital lifeline facilities, such as water and electricity supply, roads and telecommunications, hospitals and sewage systems, have to be repaired quickly, even if the repair is provisional.
- Restoring education and health systems, rebuilding damaged homes, restoring contaminated water sources and providing psychological care through counseling should be given top priority.
- Once basic lifeline services are restored, long-term development goals and plans should be consulted.
- Reconstruction provides a great opportunity to reduce vulnerability at little or no expense by implementing methods for preventing future loss.

MAN-MADE DISASTERS

Man-Made Disaster

Natural, engineering or accidental disasters, often a matter of scale.

Natural disasters may result from weather-related causes (hurricanes, cyclones, storms, floods, heatwaves, blizzards, etc.), or movements at the surface of the earth that may provoke earthquakes, volcanic eruptions or tsunamis.

Apart from natural disasters, human made disasters like conflicts, communal riots and refugee situations, road accidents and other disasters like fire, epidemics, industrial and transport disasters leave a long trail of mortality and morbidity.

Causes of Man-made Disasters

- The outbreaks caused due to technological growth are called man-made disasters.
- These are also known as Anthropogenic hazards. Man-made disasters are caused accidentally or intentionally by human beings, technology. Some of the examples of man-made disasters are industrial accidents, structure collapse, chemical spills, nuclear disasters, airplane crashes, pollution, war, radioactive spills, transport accidents, fires, war, crimes, radiological emergencies, terrorist activities, etc. These disasters also cause great loss to life as well as property.
- Most of the man-made disasters result due to human intentions, illiteracy, unawareness, negligence or error.
- Air pollution, water pollution, noise pollution, soil erosion and degradation, disease and epidemics, waste accumulation, loss of biodiversity, loss of habitat, sea level rise, global warming, deforestation, depletion of stratospheric ozone and increase in tropospheric ozone are among the ecological disasters.

Only for your information

Chemical Disasters or Accidents

• We live in a society dependent on chemical reactions to manufacture everything from the food we eat to the cleaning products we use

• Many chemical disasters have been devastating to the world that require accountability not cover ups

- The following definitions have been adopted in various existing Indian laws. "chemical accident" means an accident involving a fortuitous, or sudden or unintended occurrence while handling any hazardous chemicals resulting in continuous, intermittent or repeated exposure to death, or injury to, any person or damage to any property but does not include an accident by reason only of war or radio-activity;
- “Major chemical accident" means, - an occurrence including any particular major emission, fire or explosion involving one or more hazardous chemicals and resulting from uncontrolled developments in the course of industrial activity or transportation or due to natural events leading to serious effects both immediate or delayed, inside or outside the installation likely to cause substantial loss of life and property including adverse effects on the environment;
- A major accident is defined in the Manufacture, Storage and Import of Hazardous Chemicals (MSIHC) Rules, 1989, issued under the Environment (Protection) Act, 1986 whereas 'disaster' is defined in the DM Act, 2005..

No need to memorize line by line

- By definition, chemical disaster simply implies a disaster caused by chemical hazards.
- A chemical disaster being essentially a massive industrial accident involving chemical agents, fits into the basic definition of a disaster, i.e., it needs external help for affected people to cope-up and recover from the effects of such disasters.

CHEMICAL DISASTERS

- ❑ Disasters that are caused by the excessive use and misuse of chemicals in industries are called chemical disasters .
- ❑ The irresponsible handling of powerful chemicals can cause widespread devastation

<u>PRECAUTIONS</u>

1. Industries using harmful and powerful chemicals should be located far away from residential areas
2. There should be surveys to keep a check on their activity
3. The govt. should formulate an emergency plan to in case of an accident
4. Pollution levels should be checked and maintained

CHEMICAL DISASTERS: CAUSES

i) A Chemical disaster may take place due to anyone or more of the following.

- An accident or explosion at the production facility of hazardous material.
- An accident at the storage facility of hazardous material.
- An accident during transportation of hazardous material through populated areas.
- Inadequacies in toxic waste management. This results in long-term health effect on communities. Toxic waste can cause environmental pollution as well as ground water pollution.
- Failures in safety systems of chemical plants.
- Deliberate sabotage of a manufacturing area or storage facility of a hazardous chemical substance or a sabotage during transportation of such substance.
- Occurrence of natural disasters, such as, earthquakes, cyclones etc. can also trigger chemical

disasters essentially through damage and destruction to chemical industrial units storing or

producing hazardous material.

In neither of the following disasters, death toll needs to be memorized

ii) HUMAN ERROR

- Report says that a majority of industrial injuries happened in the service-related industry, according to the Bureau of Labor Statistics.
  When the proper equipment is not used by personnel, accidents can occur.

iv) IMPROPER TRAINING

- When personnel are not trained properly or adequately, industrial accidents are more likely to occur.
- Workers should be taught how to operate the equipment in the way it was designed to be used. They should also learn to employ correct safety procedures when they are operating the equipment.

v) Manufacturing defect:

- Although companies employ several quality-control measures during the manufacturing process, some of these may fail.
- This is because many of these control measures are handled by employees.
- Where humans are involved there is always a chance of human error.
- An inspector may miss a defect that occurred during manufacturing.

vi) IMPROPER MAINTENANCE :

When a piece of equipment is not properly maintained, it can malfunction and ultimately fail. This can result in dire consequences for the personnel who are operating and working around the machine.

From Bombay Docks Blast to Bhopal Gas Tragedy : Revisiting Major Industrial Disasters in India

Mining :

fire, explosion, suffocation, formation of chemical gases, flood, landslide or earth wall collapse

- Soma mine disaster in Turkey. An explosion occurred 2km below the surface. Fire and CO poisoning killed 301.
- Dhanbad coal mine explosion (Dholi colliery) killed 268 miners on 1965
- Chasnala Colliery disaster : killed 372 miners on 1975

  On December 27, 1975, a huge explosion rocked the Chasnala Colliery in Dhanbad (then under Bihar) killing 372 miners. The explosion is supposed to have caused by sparks from equipment igniting a pocket of flammable methane gas. The flooding in the mine drowned the miners trapped under the debris.

Bhilai Steel Plant Pipeline Blast (Ocober 9, 2018)

- An explosion in a gas pipeline connected to the coke oven section of the Steel Plant in Bhilai in Durg district of Chhatisgarh, operated by the Steel Authority of India Limited (SAIL) resulted in the death of 9 people while injuring 14 others.

Belur Chlorine Gas Leak :

More than 10 people took ill and were rushed to the hospital following a chlorine gas leak at a water treatment plant at Gandehalli in Belur near Hassan in South Karnataka on May 16, 2017.

Chlorine gas leak at Por, 19 hospitalised : near Vadodara April 14, 2017

Breathlessness, nausea and burning sensation in the throat

Powerful serial blasts shook the factory of pharmaceutical major Ranbaxy in Mohali on Wednesday night setting off a major fire that left at least 20 people injured.

Blast (on June 12, 2003) in the toluene distillation unit which operates under high pressure

- A major gas chemical leak (styrene gas) at LG Polymers Ltd in Visakhapatnam left 12 dead and thousands other sick were hospitalized : 7th May 2020.
- The gas caused severe headache, vomiting, itching, vomiting, burning sensation in eyes, breathing trouble, skin irritation and fell unconscious.
- Nearly 10,000 other residents in the vicinity were forced to vacate their homes in panic. There are also sufficient indications that the environment through which the vapours traversed has been adversely affected even a week after the tragedy.

❑ Kanpur Ammonia gas explosion

The Ammonia gas leakage triggered a powerful blast (March 15th, 2017) after which the building collapsed like a pack of cards in Kanpur. The National Disaster Response Force (NDRF) team reached the spot to investigate the accident. Many died and injured in this incident.

- NTPC Power Plant Explosion (40 dead) : On November 1, 2017 an explosion took place in the boiler of the Feroze Gandhi Unchahar coal-fired power plant in Unchahar, Uttar Pradesh.
- The boiler pipe burst in the 500Mw plant and ignited a huge fire.
- The explosion set off a lot of dust in the air. Over 100 people were injured in the incident.
- "The accident occurred in the ash-handling section of the plant and ash gushed out at high-temperature, burying several workers," and engineer at NTPC said.

❑ Explosion on cargo ship rocks Bombay, India

On April 14, 1944, a ship lying outside Mumbai's Victoria Dock caught fire, resulting in two explosions that left around a 1,000 dead, thousands injured, and several buildings in the city destroyed. The raging inferno was visible for miles across the city, and took three days of efforts by dozens of firefighters to be doused.

The cargo ship *Fort Stikine* explodes in a berth in the docks of Bombay, India killing 1,300 people and injuring another 3,000 on April 14, 1944. As it occurred during World War II, some initially claimed that the massive explosion was caused by Japanese sabotage; in fact, it was a tragic accident.

Fire

- The consequence of the released chemical will be either fire or explosion if it is flammable.
- Sudden acute incidents may occur as a result of a fire, explosion or
- other accident in the handling of chemicals at an industrial or storage site, or during the transportation of hazardous chemicals.
- Fire results in heavy damage both in terms of life and property. Loss of life is high in a crowded building.
- The toxic chemical will spread in the form of toxic cloud and the behaviour of the cloud will depend on the climatic conditions and on the amount of the released chemical.

PRECAUTIONS

1. The main reason is poor wiring and faulty electrical equipment , leaking gas or carelessly thrown cigarettes and matches
2. The main power supply source is good condition.
3. Wire should be properly covered
4. Inflammable things should be kept out of reach of children
5. Power points shouldn’t be overloaded

- A massive fire broke out early morning in Delhi's Anaj Mandi area on December 8, 2019 - illegal manufacturing units ran in the four-storey building. While 43 laborers died, over 56 people were critically injured in the fire, were rescued and sent to the hospital. As the building lacked proper ventilation, most of the people died due to asphyxia. Over 30 fire tenders were rushed to the spot to douse the fire and to carry out rescue operations. The NDRF team that entered the building said the building was filled with hazardous carbon monoxide.
- 40 killed in fireworks factory explosion in Sivakasi (a region known for frequent accidents in the match and fireworks industries) in Tamil Nadu on 5th September 2012 due to a huge explosion, the debris that flew across a wide distance injured the people seriously.

- Indian Oil Corporation Jaipur :

A huge tank with a capacity of 8,000 kilolitres of petrol at the at Indian Oil Corporation (IOC) depot in Sitapura industrial area on the outskirts of the city Jaipur caught fire on the evening of October 29, 2009.

The number of deaths was pegged at 12 with hundreds of others were injured. The blaze continued for more than a week and half a million people were evacuated from the area post the incident.

Thousands of people were evacuated after petrol fumes made breathing difficult.

BHOPAL DISASTER

- The Bhopal disaster, also referred to as the Bhopal gas tragedy, was a gas leak incident in India, considered one of the world's worst industrial disasters.
- It occurred on the night of 2–3 December (around 1:00 am on Monday) 1984 at the Union carbide India limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh.
- Over 500,000 people were exposed to methyl isocyanate gas and other chemicals.

- 2500 DEATHS IN 48 HOURS
- Another 13,000 died in next fifteen years
- 520,000 diagnosed chemicals in blood causing different health complications
- 120,000 people still suffering from

Cancer Tuberculosis
Partial or complete blindness,
Post traumatic stress disorders,
Menstrual irregularities

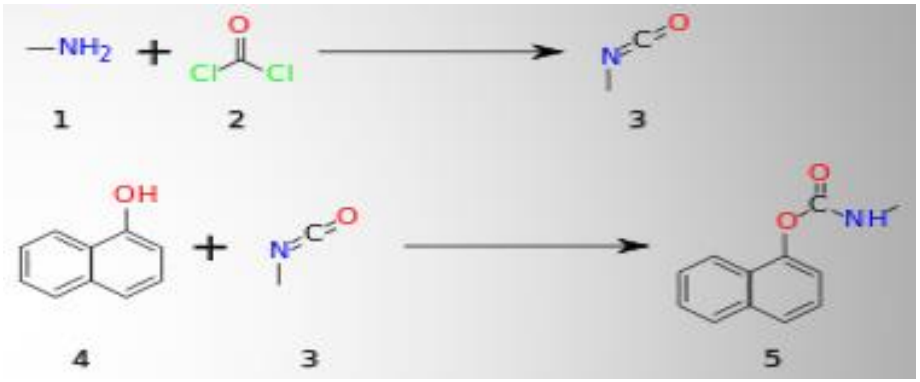
Rise in spontaneous abortion and stillbirth

CAUSES :

- A storage tank containing Methyl Isocyanate (MIC), which is used to make the insecticide Carbaryl was exposed to water that leaked into the storage tank containing 40 cubic meters of MIC.
- When H_2O and MIC mixed an exothermic chemical reaction (the temperature inside the tank increased to over 200 °C) occurred and the pressure increased - forced the pressure release valve to open and burst and released 20-30 tons of MIC into the atmosphere within 1 hour.

Reactions and Products

• Methylamine (1) reacts with phosgene (2) producing methyl isocyanate (3) which reacts with 1-naphthol (4) to yield carbaryl (5)



Night of Disaster

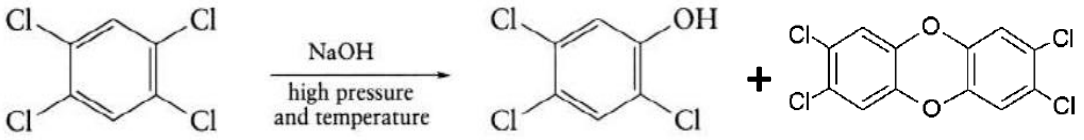
- $2CH_3NCO + H_2O \rightarrow C_3H_8N_2O + CO_2 + heat$
- Methyl isocyanate + water yields 1,3-dimethylurea + carbon dioxide and heat
- $CH_3NCO + C_3H_8N_2O \rightarrow C_5H_{11}N_3O_2 + heat$

with xs MIC 1,3-dimethylurea 1,3,5-trimethylbiuret

Major Industrial Disasters across the globe (outside India)

THE SEVESO ACCIDENT

- An explosion occurred at the ICMESA chemical plant at Seveso, Italy in a 2,4,5-trichlorophenol reactor (TCP) in 1976 during the production of TCP.
- Desired product :2,4,5 trichlorophenol sodium salt (TCP) - is an industrial chemical used as a building block to make pesticides and antiseptics, soaps , shampoos and cosmetics
- Byproduct :2,3,7,8 tetrachloro dibenzo dioxin (TCDD)
- It was possibly caused by an exothermic reaction with increase of temperature, slow decomposition of the reaction mass, formation of gas and rise in pressure.
- Death toll : no people died as an immediate result. Around 3,300 domestic animals (including poultry) perished within days and another 80,000 were slaughtered



2,4,5-Trichlorophenol

Byproduct (TCDD)

A toxic cloud containing dioxins, which are very potent cancer-causing chemicals, was released into the atmosphere and spread across the nearby densely populated city of Seveso.

Oppau explosion

An explosion occurred at an ammonium sulfate nitrate silo in Oppau, Germany on September 21, 1921. Ammonium sulfate nitrate is a mixture of 2 salts: ammonium nitrate (explosive) and ammonium sulfate (inert). 500-600 people were killed and 2000 injured

Beirut Explosions:

At least 73 were killed and 3,700 injured following two enormous explosions that rocked the Lebanese capital of Beirut on August 4, 2020. A column of smoke rose from the port area from what appeared to be an initial explosion, followed by a massive blast that sent up a mushroom cloud and a shock wave racing over the city. Lebanon Prime Minister Hassan Diab said that “It is unacceptable that a shipment of 2,750 tonnes of ammonium nitrate has been present for six years in a warehouse, without taking preventive measures,”.

Cause of Jilin chemical plant blasts found

By Wu Yong and He Na (China Daily)
Updated: 2005-11-15 06:13

JILIN: A blockage in a chemical plant's processing tower and a worker's botched attempt to clear it caused the explosions in Northeast China's Jilin Province on Sunday, according to the top official from China National Petroleum Corporation (CNPC).

The channel of one nitration tower of the benzene production branch got blocked at noon. A worker then bungled an attempt to unblock it.

Chernobyl Nuclear Disaster

A major industrial accident, on April 26, 1986 at Chernobyl nuclear power plant, in northern Ukraine was the result of flawed reactor design combined with a number of errors from operators. About 60 percent of the fallout landed in Belarus.

Damage: Between 1986 and 2000, more than 350,000 people were evacuated from Belarus, Russia and Ukraine. Continuing analysis estimate 4,000 deaths. This does not include about 50,000 people living with cancer, of whom 25,000 are expected to die. Flora and fauna in the area was heavily affected, with animals and trees either dying or not reproducing. The effects are expected to remain for the next 100 years, with declining intensity.

IHOP is an American multinational pancake house restaurant chain that specializes in breakfast foods.

- On February 17, 2012 a toxic cloud of Chloramine gas spread throughout the restaurant
- 50 people had respiratory injuries
- 9 people's injuries were severe enough to be hospitalized

Products and Reactions

- The NaOCl Sodium Hypochlorite bleach decomposed to form HOCl Hypochlorous acid, which reacts with ammonia to form toxic Chloramine fumes
- $NaOCl + H2O \rightarrow NaOH + HOCL$

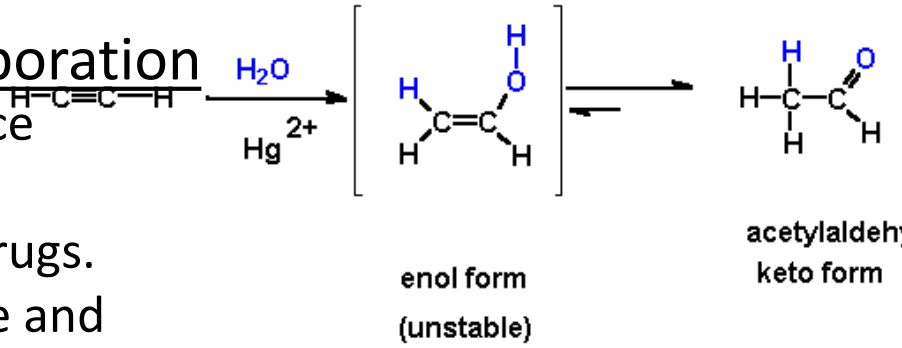
Then the Ammonia NH3 and HOCl react to form Chloramine NH2CL , which is released as a vapor

- $NH3 + HOCl \rightarrow NH2Cl + H2O$

CAUSES

- A kitchen employee mixed chlorine bleach and a delimer (it is a lime scale remover, containing ammonia), which contained ammonia as its main ingredient, to clean a dishwashing machine.
- The mixture of the two chemicals created a chemical reaction producing the poisonous Chloramine NH2Cl vapor that spread through the restaurant

Minamata disease by Chisso Corporation



- 1932 : Chisso plant begins to produce acetaldehyde to be used in the production of plastic, perfume and drugs.
- Acetaldehyde is made from acetylene and water with a mercury catalyst.
- Plant continued dumping untreated wastewater into Minamata Bay for next 36 years
  - Kills fish
  - Fisherman Payoffs
- After WWII plastic production boomed and Chisso Corp. grew.
- By early 1950s : Mercury moves up the food chain.
- Estimates are that human sources have nearly doubled or tripled the amount of mercury in the atmosphere.

The Aftermath :

- 30-70 tons of methyl mercury was dumped into the Bay
- 10,000 people affected by Minamata disease; 3,000 died.
- Compensation has been given to families as recently as 1990.

Severe cases cause - Insanity , Paralysis, Coma , even death

- Fetal Minamata Disease

  A pregnant mother ingests toxic fish and the methylmercury concetrates inside the placenta.

  Harms the fetus while the mother is relatively unaffected

Natural disaster induced industrial disasters

- Natural disasters may result in industrial disasters as well.
- This was the case when heavy rainfall following a typhoon caused the collapse of the Banqiao dam in China in 1975, resulting in the immediate death of more than 25000 and, indirectly, of 250 000 later.
- This was the case also on March 11, 2011, when an earthquake in the Pacific Ocean some 70 km east of Japan provoked a tsunami resulting in a major nuclear accident at the Fukushima-Daiichi nuclear power station.
- Power supply was disrupted following the earthquake and disabled the cooling of three reactors, causing a nuclear accident
- Japan earthquake and tsunami of 2011, also called Great Sendai Earthquake (magnitude 9.0) or Great Tōhoku Earthquake, severe natural disaster that occurred in northeastern Japan on March 11, 2011.
- No radiation casualties occurred at the time, but the government ordered the evacuation of over 100 000 people living within a 20-30 km radius of the plant.

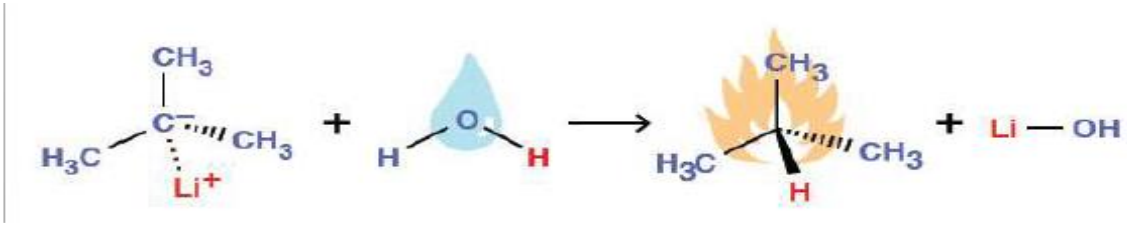
UCLA Laboratory Fire

One of the most infamous chemical accidents in a college laboratory resulting in death occurred on December 29, 2008

- Research assistant, Sheri Sangji, worked in the UCLA chemistry laboratory testing a reaction she had previously tested in the attempt to produce more product.
- She had detailed lab notes for the procedure
- However fatal mistakes were made costing her life
- Sangji planned to generate vinyllithium by reacting vinyl bromide with two equivalents of tert-butyllithium,

t-BuLi, as the first step of a larger synthesis.

- t-BuLi is a pyrophoric chemical, which ignites spontaneously in the presence of oxygen
- t-BuLi + O2 → t-BuOOLi t-BuLi + H2O → t-BuH + LiOH



CHEMICAL DISASTERS: Impacts

- Chemical disasters lead to serious and varied impacts. These can result into explosions and/or fires.
- The most hazardous impact of a chemical disaster lies in the extreme pollution of air, water and food chain upto life-threatening levels even.
- The long-term health impairment can even extend to coming generations.
- A chemical disaster may result into one or all of the following.

Physical Damage

- This includes damage or destruction of structure and infrastructure. A transportation accident may
- damage the means of transport used for transporting hazardous material viz. vehicle, rail etc.
- Industrial fires, if not contained, may affect large areas.
- Chemical disaster may result in large-scale casualties. While quick medical relief is essential to save lives, immediate disposal of dead bodies will also need planning.

read out the lines, but no need to memorize line by line

Environmental Damage : In addition to loss of life, the major consequences of chemical disasters include impact on livestock, flora/fauna, the environment (air, soil, water) and losses to industry. In some cases' certain areas may become uninhabitable for humans and animals. The possibility of mega scale migration/evacuation/resettlement could loom large.

The most common chemical spills results from petroleum spills - most of the petroleum floats on the water's surface. It causes environmental damage by coating the feathers of birds and the gills of fish, physically disrupting their movements and their ability to breathe.

Typical demands on health services

In case of an explosion or transport accident:

- ❑ treatment of casualties
- ❑ psychological trauma care

In case of an incident involving release of toxic chemicals:

- ❑ assessment of public health risks, decision on 'best outcome' approach to managing the situation.
- ❑ implementation of measures to protect people and their environment (by public health services)
- ❑ treatment and monitoring of exposed people (by medical services)

Preparation of On-site and Off-site Emergency Management Plans

- Emergency management plans need to be prepared for on-site and off-site contingencies.
- On-site contingencies are those where the impact of the accident is localised and it is likely to cause
  damage or destruction of plant and equipment or injury or loss of life to workers.

In off-site emergencies, the impact of the accident is widespread i.e. beyond the premises of a hazardous industrial unit.

The chemical disaster management plans should generally include the following aspects:

- Awareness among workers and the people likely to be affected.
- Procedure for warning.
- Fire fighting arrangements.
- Plan for casualty evacuation and medical aid.
- Specific responsibilities of officials and their training.
- Command, Control and Communication system.
- List of specialists, personnel, and organisations who could provide assistance.
- Immediate action to be taken.
- Practice Drills.

Memorize at least first 5 points

HOW ARE CHEMICAL ACCIDENTS (*IN CASE OF CHEMICAL SPILL*) HANDLED?

- Emergency response personnel are involved in assessing the risk of hazardous material releases and working to avoid any harmful effects.
- Teams of workers evaluate the concentrations of the chemicals, where and how people might be exposed, and potential toxic effects on the exposed people.
- If a spill occurs, they use source databases of chemical properties, and chemical movement models to rapidly predict the movement of contaminants and the toxicity of the spilled chemicals.
- If rapid spill cleanup is necessary, the emergency response team designs and implements cleanup measures to protect exposed populations and ecosystems from toxic responses.
- A wide range of cleanup systems has been developed for chemical spills. Newer, more innovative methods for spill cleanup include bioremediation (using bacteria to metabolize the contaminants) and chemical oxidation (using oxidants, such as hydrogen peroxide and ozone to break the chemicals down).
- Oil spills on water are contained using floating booms and adsorbents, or solid materials that capture the soil, so that it can be disposed of in landfills.

CHEMICAL DISASTER MANAGEMENT: INSTITUTIONAL ASPECTS

i) Recognizing the gravity of the risk posed by Hazardous Chemicals, the NDMA took up the task of strengthening Chemical Disaster Management.

- In India, at the Central Government level, the Ministry of Environment and Forests (MoEF) is the nodal agency for management of Chemical disasters. The ministry maintains a nationwide list of major hazardous units.
- The other stakeholders in the management of chemical disasters are - Ministry of Home Affairs (MHA); Ministry of Health and Family Welfare (MoH &FW); Ministry of Labour and Employment (MoLE); Ministry of Agriculture (MoA); Ministry of Shipping, Road Transport and Highways (MoSRT & H); Ministry of Defence (MoD); Ministry of Chemicals and Fertilizers (MoC& F); Ministry of Petroleum and Natural Gas (MoP & NG), Department of Atomic Energy (DAE); state governments and Union Territories (UTs) and the chemical industries.
- The Guidelines have been prepared to provide directions to ministries, departments and state authorities for the preparation of their detailed Disaster Management (DM) plans.

ii) A layered structure to manage the chemical disasters at central, state, district and local levels is stipulated. For this, Crisis Management Groups are required to be nominated at each level as under:

a) Central Government National Level
b) Chief Secretaries of State State level
c) District Collector District and Lower Levels

- As disaster management is a multi-disciplinary process, all Central Ministries and departments have a key role in the field of disaster management.
- However, Ministry of Home affairs (MHA) is the nodal ministry for most natural disasters and emergencies related to internal security. The Secretaries of the Nodal Ministries and Departments of GOI i.e. the Ministry of Home Affairs (MHA), Agriculture, Civil Aviation, Environment and Forests, Health, Atomic Energy, Space, Earth Sciences, Water Resources, Mines, Railways etc. are all members of the NEC and function as nodal agencies for specific disasters based on their core competencies or as assigned to them.

iii) As per law, all industrial accidents have to be reported to the Director General Factory Advice Service and Labour Institutes (DGFASLI).

Institutional Framework

Disaster Management Structure

NDMA Apex Body with Prime Minister as Chairperson.
National Executive Committee - Secretaries of 14 Ministries and Chief of Integrated Defence Staff.

Centre Level

Central Ministries; National Disaster Management Authority,
National Institute of Disaster Management
National Disaster Response Force (NDRF).

State Level

SDMA headed by Chief Minister.
State Executive Committee (SEC).

District Level

DDMA headed by District Magistrate.
Interface between Govt. and Public.

- At state level, the State Disaster Management Authority (SDMA) provides policy framework for disaster management.
- State Disaster management Authorities (SDMAs) are headed by Chief Minister of the State as chairperson except in Gujrat and Orissa.
- The State Executive Committee (SEC) works as a functional subcommittee of the SDMA.
- The Disaster Management Act of 2005 requires the formation of State Disaster management Authority (SDMA) u/s 14.
- The Block Development Officer (BDO) and the Circle Officer (CO) are the two key officers responsible for management of disaster at the Block level.
- Ideally, comprehensive assessment of the required response to a disaster or impending disaster is needed. This will facilitate deployment of the necessary resources i.e., armed forces, NDRF, Police, Civil defense, home guards without loss of time to limit the damage and losses to a minimum.

• NIDM observes "Disaster Reduction Day" on the Second Wednesday of October.
• UN General Assembly in 2009, designated October 13 as International Day for Disaster Reduction.