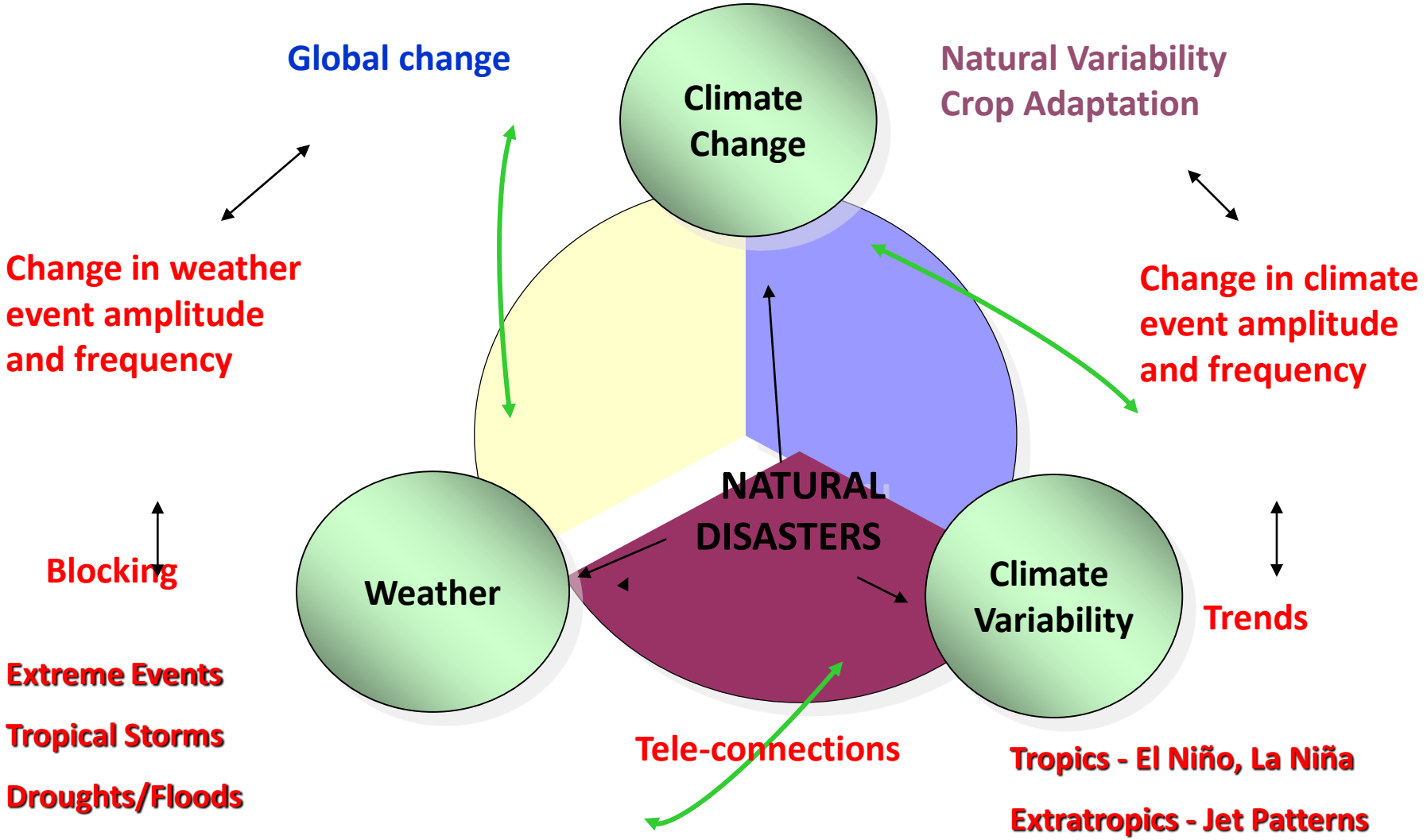
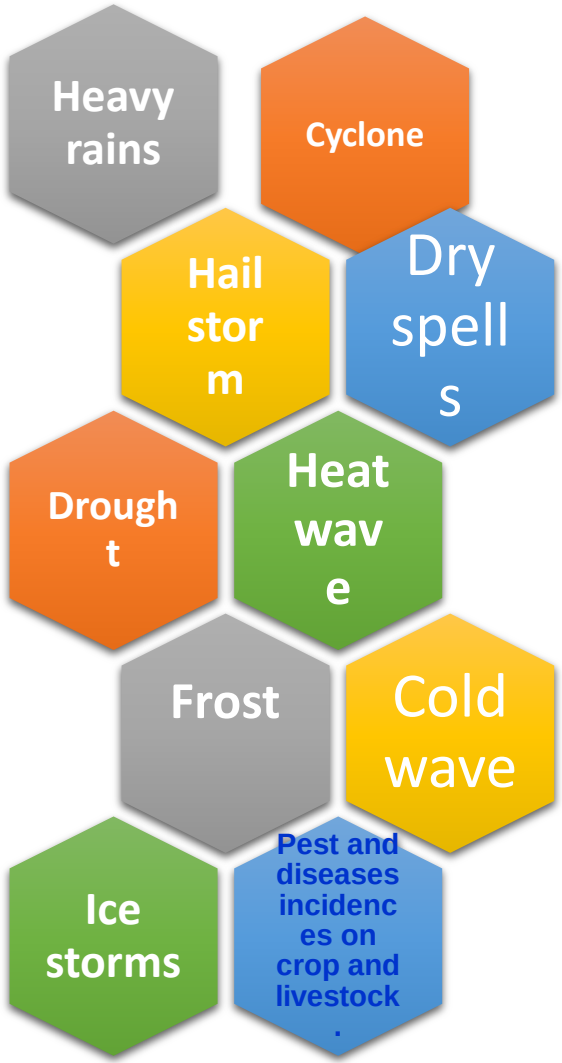
Extreme Events Management, Remote Sensing, Climate Variability & Adaptation

Agro-Meteorological Information Systems Development Project
Component-C of Bangladesh Weather and Climate Services Regional Project
Department of Agricultural Extension (DAE), Ministry of Agriculture,Bangladesh

Coping with Natural Disasters
Agrometeorological Perspective



Extreme weather events affecting agriculture



Bangladesh

Winter (Jan-Feb): Western Disturbances, Cold Wave, Fog

Pre-Monsoon (Mar-May): Cyclonic Disturbances, Heat Wave, Thunder Storms, Squalls, Hail Storm, Tornado

Monsoon (Jun-Sep): Southwest Monsoon Circulation, Monsoon Disturbances

Post-Monsoon (Oct-Dec): Northeast Monsoon, Cyclonic Disturbances

Floods:1988,1998, 2004, 2007 and 2010.

Drought :1961, 1975, 1981, 1982, 1984, 1989, 1994, and 2000.

Bhola **Cyclone** (November 11, 1970):. Barisal Cyclone (May 11, 1965): : Urir Char Cyclone (May 25, 1985):. Cyclone Sidr (November 15, 2007 Cyclone Aila (May 25, 2009):. Cyclone Mahasen (May 16, 2013): Cyclone Roanu (May 21, 2016), 20 August 2016: Cyclone Mora, 4 May 2019: Cyclone Fani made 9 November 2019: Cyclone Bulbul

Extreme Weather events which need contingency measures

- Delay in onset of monsoon
- Timely sowing but long dry spell in monsoon
- Unusual rains
- Drought
  - A. rain-fed region
  - B. irrigated condition
- Flood
- Extreme events
  - A. Heat Wave
  - B. Cold wave, Frost
- Cyclone
- Hailstorm

Contingent Planning

- **Contingency planning refers to mitigate any unexpected, unusual, unfavourable and hence unwanted weather situations occurring at any time without prior knowledge at any time before the crops are sown or even after the crops are sown.**
- **Contingency crop planning therefore is proposed to mitigate such situations through choice of appropriate crop and varieties, cropping systems or other necessary relevant farm practices.**

Delay in onset of monsoon

If the onset of monsoon is delayed crop/varieties recommended to the region cannot be sown in time. Delay sowing of crops lead to uneconomical crop yields

Crop field is ready to sow the crop

Farmer looking at the sky

Timely Sowing but prolonged dry spell in crop growing period

Breaks of monsoon for 7-10 days may not be serious concern but if it is more than 15 durations especially at critical stages for soil moisture stress leads to reduction in yield. The adverse effect of moisture

Mulching in maize to conserve soil moisture

Prolonged dry spell on rice crop

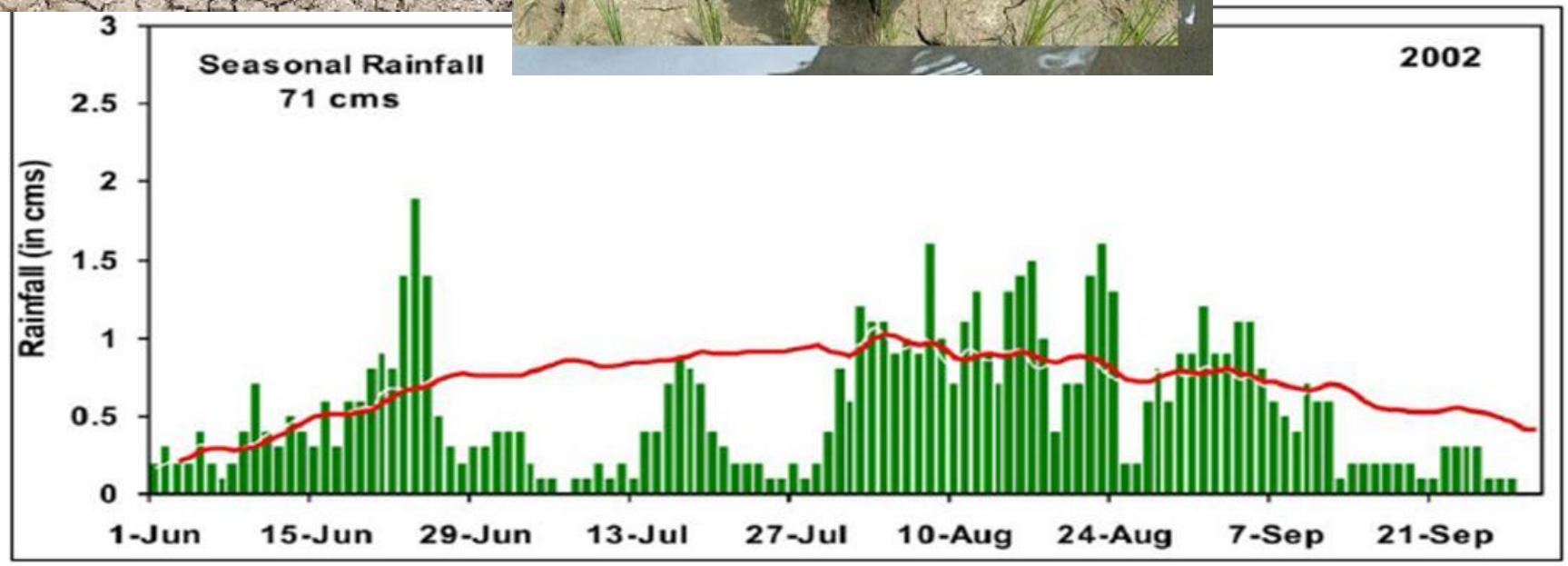
Unusual and unseasonal rains

Continuous high rainfall in short span leads to water logging and if coupled with high winds at various growth stages of crops leads to serious crop losses.

Contingency measure includes re-sowing if crop is at early stage, providing surface drainage, application of hormones / nutrient sprays to prevent flower drop or promote quick flowering / fruiting and plant protection measures against pest / disease outbreaks with need based prophylactic curative interventions.

Submerged crop due to Heavy rains

Drought


Seasonal Rainfall
71 cms
2002
Rainfall (in cms)
3
2.5
2
1.5
1
0.5
0
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
10-Aug
24-Aug
7-Sep
21-Sep

DROUGHT

- **is the consequence of a natural reduction in the amount of precipitation over an extended period of time, usually a season or more in length, often associated with other climatic factors (viz. high temperatures, high winds and low relative humidity) that can aggravate the severity of the event (WMO No. 869, 1997).**

DROUGHT

- **METEOROLOGICAL DROUGHT**
- **HYDROLOGICAL DROUGHT**
- **AGRICULTURAL DROUGHT**
- **SOCIO-ECONOMIC DROUGHT**

METEOROLOGICAL DROUGHT

- **Drought over an area is defined as a situation when the seasonal rainfall received over the area is less than75% of its long term average value.**

- **It is further classified as "moderate drought" if the rainfall deficit is between 26-50% and "severe drought" when the deficit exceeds 50% of the normal.**

HYDROLOGICAL DROUGHT

- **HYDROLOGICAL DROUGHT can be defined as a period during which the stream flows are inadequate to supply established use of water under a given water management system.**

- **HYDROLOGICAL DROUGHT year can be defined as one in which the aggregate run off is less than the long-term average runoff. Most of the criteria developed for hydrological drought are specific to individual streams or river basins.**

AGRICULTURAL DROUGHT

It occurs when available soil moisture is inadequate for healthy crop growth and cause extreme stress and wilting.

AGRICULTURAL DROUGHT CATEGORIES

- Early season drought
- Mid season drought
- Late season drought
- Permanent drought
- Apparent drought

SOCIO-ECONOMIC DROUGHT

- **Abnormal water shortage affects all aspects of established economy of a region.**

- **This in turn adversely affects the social fabric of the society creating unemployment, migration, discontent and various other problems in the society.**

- **Thus, meteorological, hydrological and agricultural drought often lead to what is termed as ‘Socio-economic drought’.**

Drought – Irrigated condition

Delayed / limited release of water in canals due to low rainfall
Non-release of water in canals under delayed onset of monsoon in catchments
Lack of inflows into tanks due to insufficient / delayed onset of monsoon
Insufficient groundwater recharge due to low rainfall

Impact of drought on Agriculture

- Drastic reduction in seed reserves
- Migration to nearby cities
- Reductions of stream flow
- Reduction of reservoir levels
- Reduction of irrigation potential
- The acreage planted to food crops is also affected by land quality
- Wind erosion

Drought in rain-fed region

Delayed onset of monsoon by 2 wks (Alert phase), 4 wks (Warning), 6 wks (Emergency), 8 wks (Acute phase) :

Normal onset followed by long dry spell

Mid-season drought – vegetative / reproductive stages

Terminal drought

Suggested contingency measures:

- Change in crop, variety
- Appropriate Agronomic measures
- Implementation, linkage issues, sources of seed/ inputs etc

Droughts

- **No operational procedure to forecast drought with respect to area of impact, extent & duration.**
- **Update mapping of drought prone areas for development planning.**
- **Changing cropping calendars and patterns appear the only solutions envisaged there in present planning exercises.**
- **Bottlenecks- Insufficient considerations of the actual conditions of livelihood of farmers leading to development of inappropriate support systems.**
- **Role of Local government and NGO in reducing local vulnerabilities.**

Drought Monitoring

Aridity Anomaly Index

Aridity anomaly index (AI) developed on the lines of Thornthwaite's concept is used to monitor the incidence, spread, intensification, and recession of drought. AI is given as

$$AI = \frac{PE - AE}{PE} \times 100$$

where PE is potential evapotranspiration calculated with the help of Penman's formula, which takes into account mean temperature, incoming solar radiation, relative humidity, and wind speed.

AE is actual evapotranspiration calculated according to Thornthwaite's water balance technique, taking into account PE, actual rainfall, and field capacity of the soil.

arid areas are demarcated as follows:

Aridity Anomaly	Areas
0 or negative	Non-arid
1 – 25	Mild arid
26-50	Moderate arid
> 50	Severe arid

With the help of aridity anomalies, crop stress conditions in various parts of the country can be monitored during the monsoon season. These anomalies can be used for crop planning and in the early warning system during drought/desertification.

This is an useful index for monitoring agricultural drought at 15 days interval.

Standardized Precipitation Index (SPI)

Standardized Precipitation Index (SPI) may be defined as follows:

$$SPI = \frac{X_i - \overline{X}}{\sigma}$$

Where, X_i is the rainfall for the period under consideration for i^{th} year, X is the mean rainfall and σ is the standard deviation of corresponding period. Depending on SPI values categories of rainfall situation for a particular period can be determined as follows:

Category of SPI range:

Normal : –0.5 to 0.5σ

Moderate drought: –1.0 σ to less than –0.5 σ

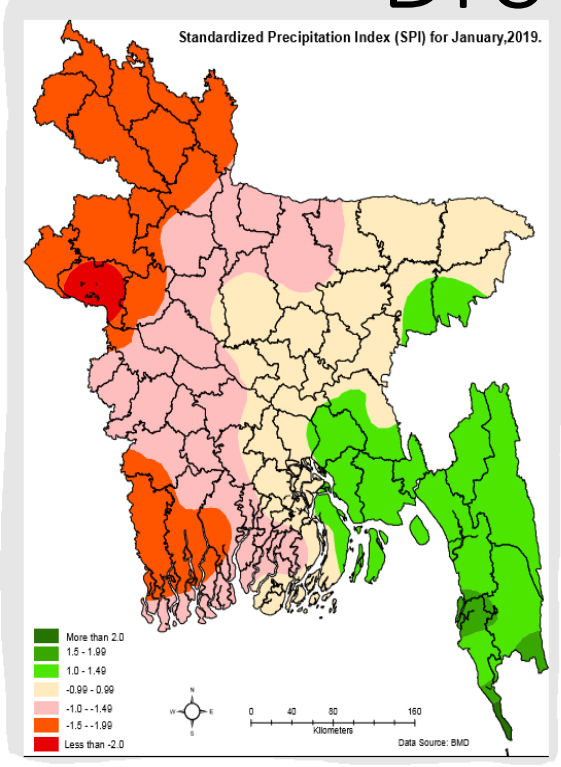
Severe drought: Less than –1.0 σ

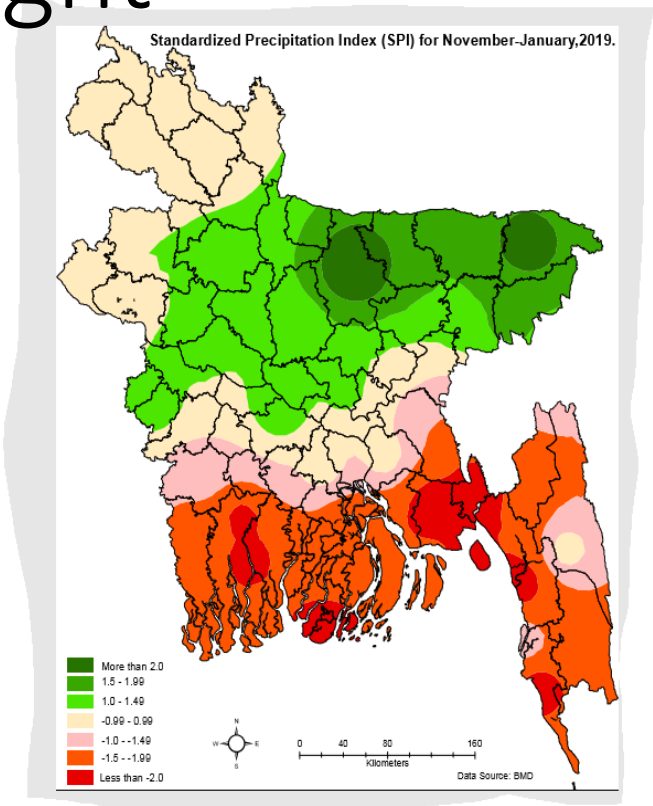
Standardized Precipitation Index (SPI)

Standard Precipitation Index (SPI) is a relatively new drought index based only on precipitation. It's an index based on the probability of precipitation for any time scale.

SPI	CATEGORIES
More than +2.0	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
Less than -2.0	Extremely Dry

Drought



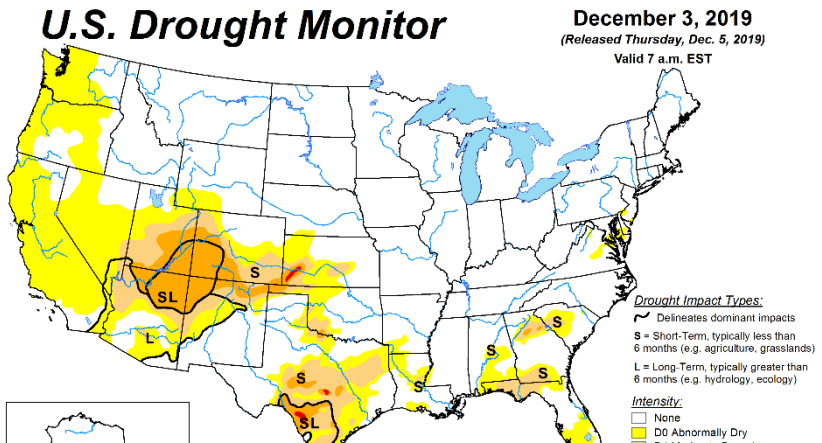


Standard Precipitation Index (SPI)

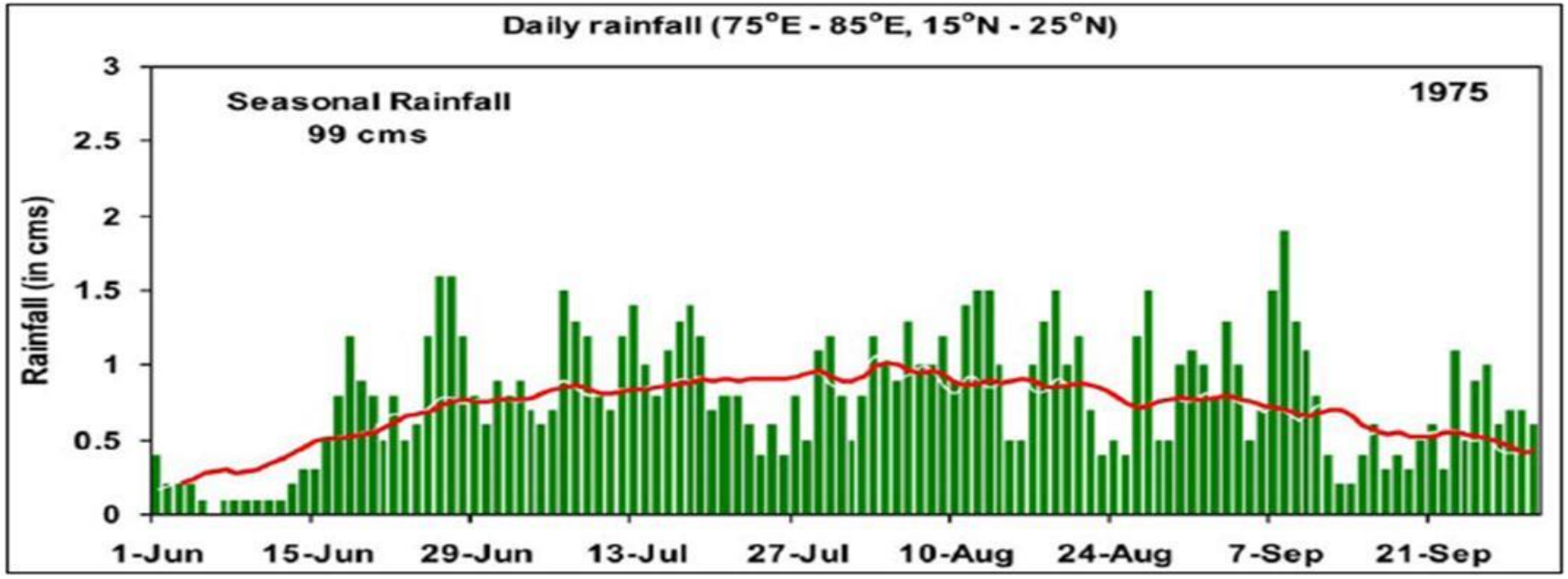
Advisory for drought situation

Farmers are advised to undertake sowing of relatively early maturating varieties of rice in place of medium and late duration varieties under rainfed conditions to avoid drought conditions at the time of maturity.

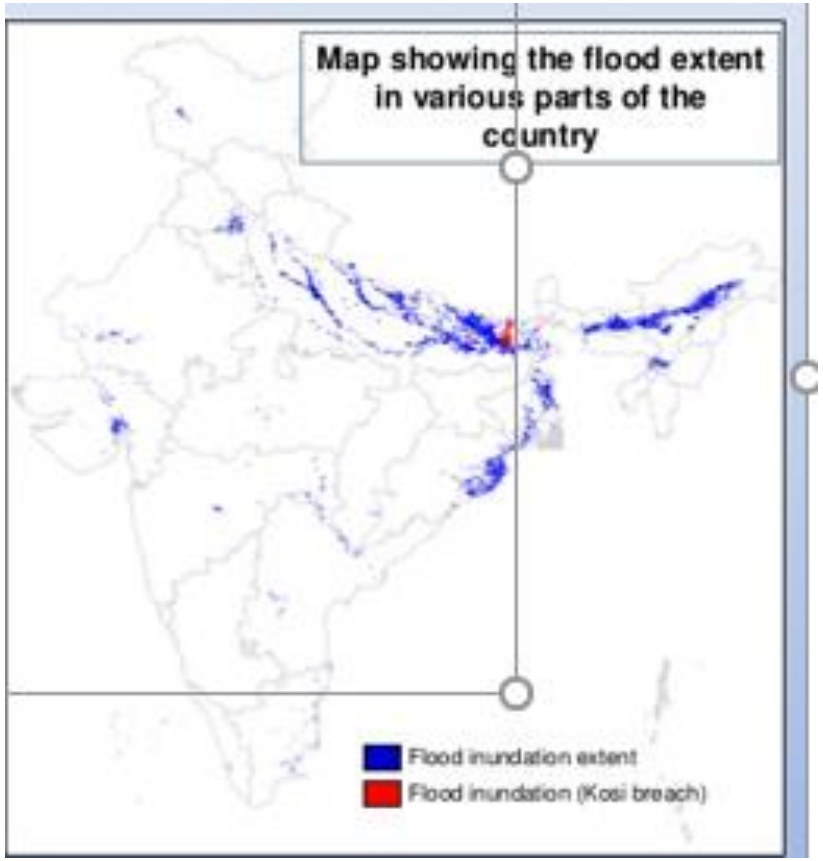
Composite Drought Index



FLOOD


Daily rainfall (75°E - 85°E, 15°N - 25°N)
Seasonal Rainfall
99 cms
1975
Rainfall (in cms)
3
2.5
2
1.5
1
0.5
0
1-Jun
15-Jun
29-Jun
13-Jul
27-Jul
10-Aug
24-Aug
7-Sep
21-Sep

Flood Prone Haor Region



Floods

1.Water logging due to heavy rainfall, poor drainage in vertisols, flash floods in streams and rivers due to high rainfall, breach of embankments

2.If the water remains in the field due to continuous rains, poor infiltration and push back effect

3.Entry of sea water into cultivated fields in coastal districts due to tidal wave during cyclones or tsunami

Impacts of flood on agriculture

- Depletion of oxygen available to the plant root zones.
- Creates anaerobic soil conditions that can have significant impacts on vegetation.
- Chemical reactions in anaerobic soils lead to a reduction in nitrate and the formation of nitrogen gas.
- The denitrification can be a significant cause of loss of plant vigour and growth following flooding.
- Causes several physical, chemical and biological changes, some of which are not reversible.

Flash Flood Forecast

Flash flood Guidance system

- Rainfall threshold analysis in flash flood pilot areas
- Establishment of Real Time rainfall station in Sylhet and Cox's Bazar
- Web based flash flood guidance and dissemination system development
- Uses WRF 3 days and ECMWF 10 days Rainfall Forecast

Flood Forecasting and Warning Center (FFWC) of the **Bangladesh Water Development Board (BWDB)** under the **Ministry of Water Resources (MoWR) and Department of Agriculture Extension (DAE), Ministry of Agriculture** will jointly issue flood forecast & Agromet Advisories under flood like situations

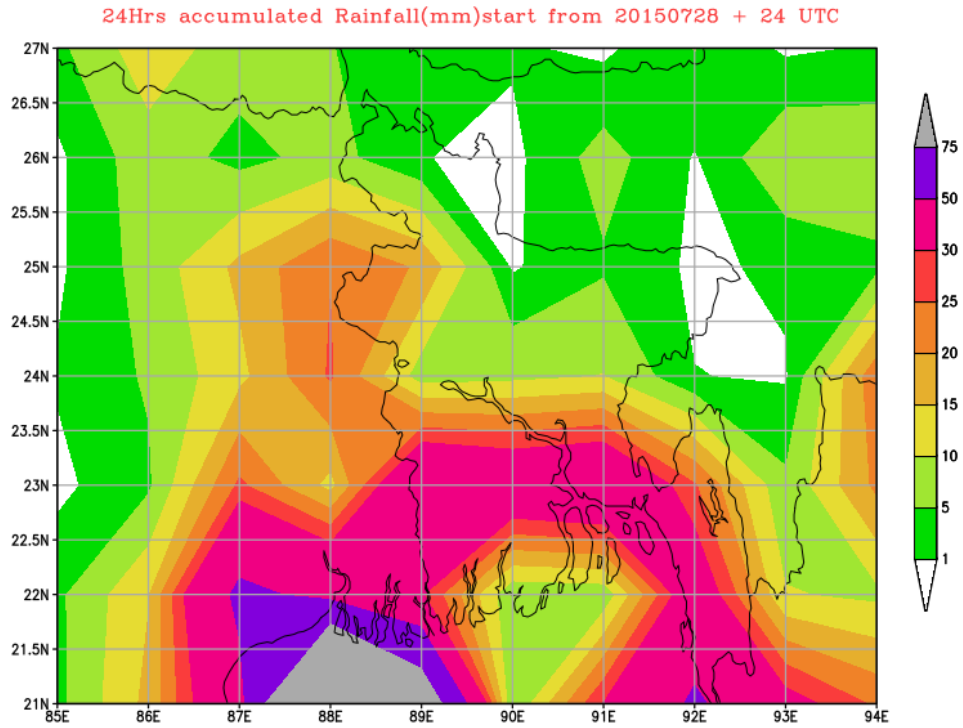
Accumulated Rainfall of Cox's Bazar (mm)

Duration (hrs)	28-07-2015	29-07-2015	30-07-2015	31-07-2015	01-08-2015	02-08-2015	03-08-2015
24	76	171	109	64	28	11	5
48	76	247	280	173	93	39	16
72	76	247	356	345	201	104	44
120	76	247	356	420	449	384	218
168	76	247	356	420	448	459	465
240	76	247	356	420	448	459	464
Advisory	NFF	FFW	FFW	FFW	FFA	FFA	FFA

Flash Flood Advisory

FFW: Flash Flood Warning	Flash Flood Warning on 29-07-2015 to 31-07-2
FFA: Flash Flood Alert	Flash Flood Alert on 01-08-2015 to 06-08-2015
NFF: No Flash Flood	No Flash Flood on 28-07-2015

Create Advisory



Advisories under Flood

- In flood affected areas (Assam) farmers may transplant aged seedlings of local varieties like Monoharsali, Andreusali, Prasadbhog etc.
- It is required to give more seedlings per hill in this situation.
- Nursery raising of the photo insensitive short duration variety like Luit, Kopilee and Culture-1 for where the rice crop was totally damaged.
- Late transplanting upto 1st week of September can be carried out with these varieties.

Key interventions	Purpose
Apply soil and raise the embankment for control fishes during flood. Put net around the fish ponds	➢Prevent escape of cultured fish and entry of predatory fish.
Renovation of dykes of ponds and establishment of horticultural plants to control flood waters	➢ Prevent water contamination and change in water quality

Animal Husbandry

- During flood, prevent the livestock from feeding rotten grasses after flood.
- Instead, feed the animals with concentrate and green grasses along with vitamins and mineral supplements.
- After recession of flood, domestic animals are infected by worms.
- To reduce the problem, it is advised to give appropriate medicine at recommended dose in consultation with local veterinary doctor.

Impact of heavy rainfall on agriculture

- Soil erosion
- Disruption to critical agricultural activities
- Water logging of crops
- Increased moisture leading to increased problems with diseases and insects
- Soil moisture saturation and runoff
- Soil temperature reduction
- Grain and fruit spoilage
- Transportation interruption
- Nutrient deficiency

Agromet Advsories

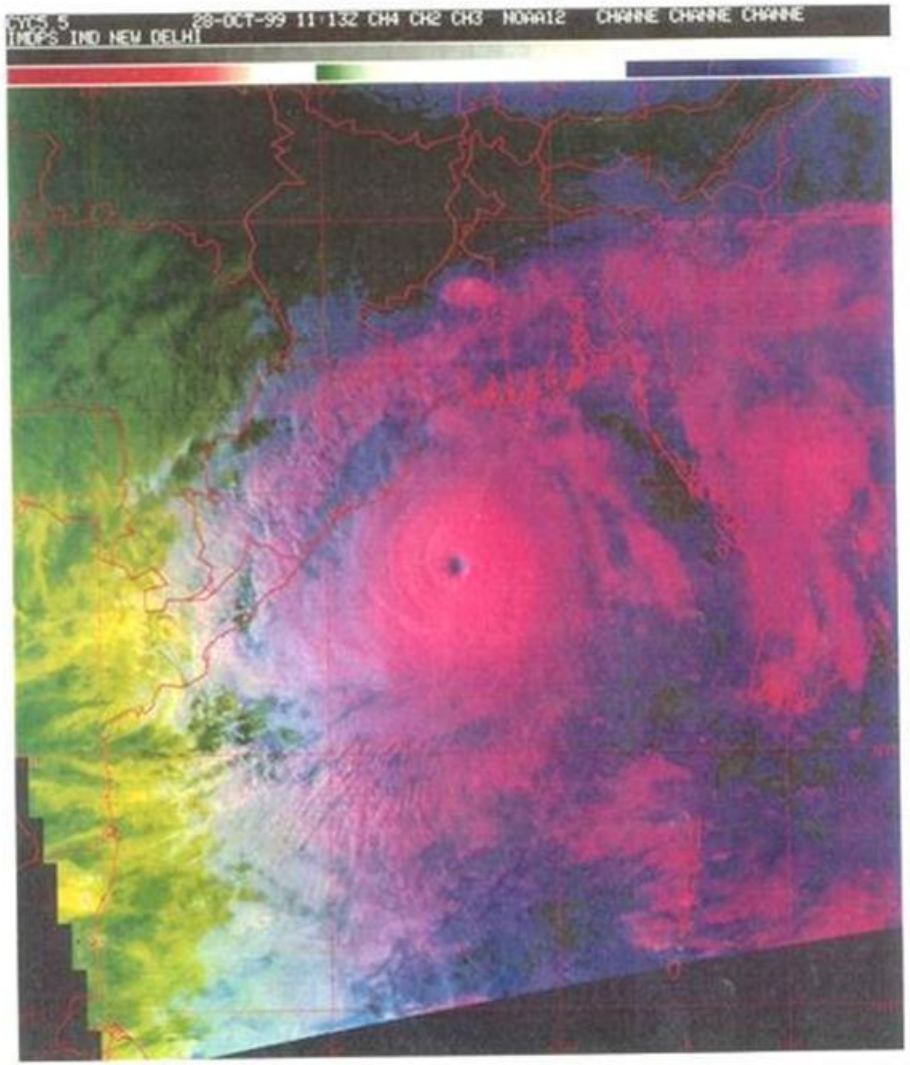
Heavy Rainfall

.Arrange for adequate drainage to avoid water stagnation in the crop fields.

•Drain out excess water from the standing crop fields if heavy rain continues.

Tropical Cyclones

Tropical cyclones are large synoptic scale weather systems which originate over warm oceans, develop into massive vortices comprising of swirling winds, intense clouds and torrential rains by drawing energy from the ocean and move land.



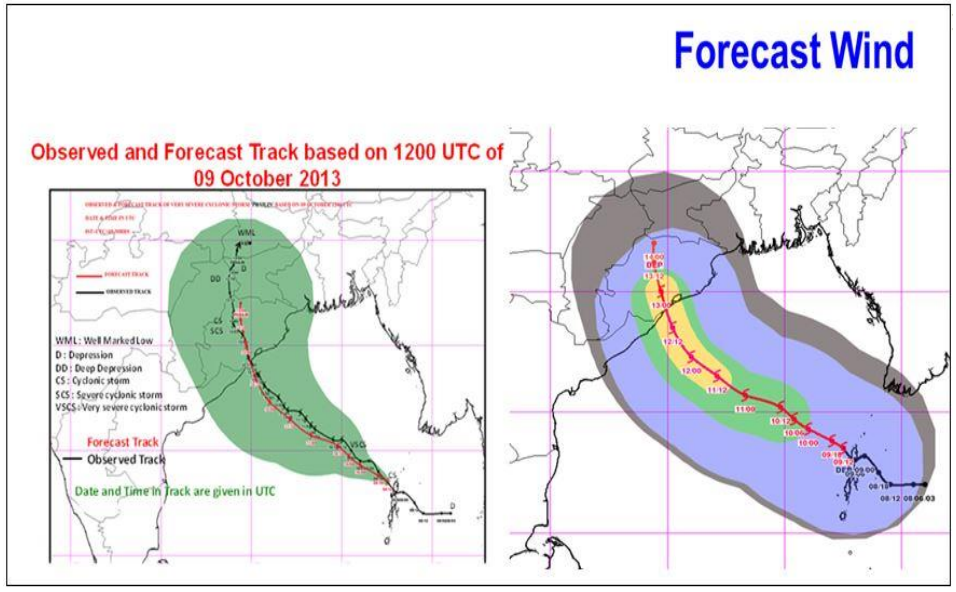
Cyclone

- The entire coast is affected by cyclones with varying frequency and intensity
- Inundation of cropped areas and sea water intrusion are associated with cyclonic events.
- Contingency measures include providing field drainage, staking and propping of plantation crops, cleaning and drying of harvested crops etc.

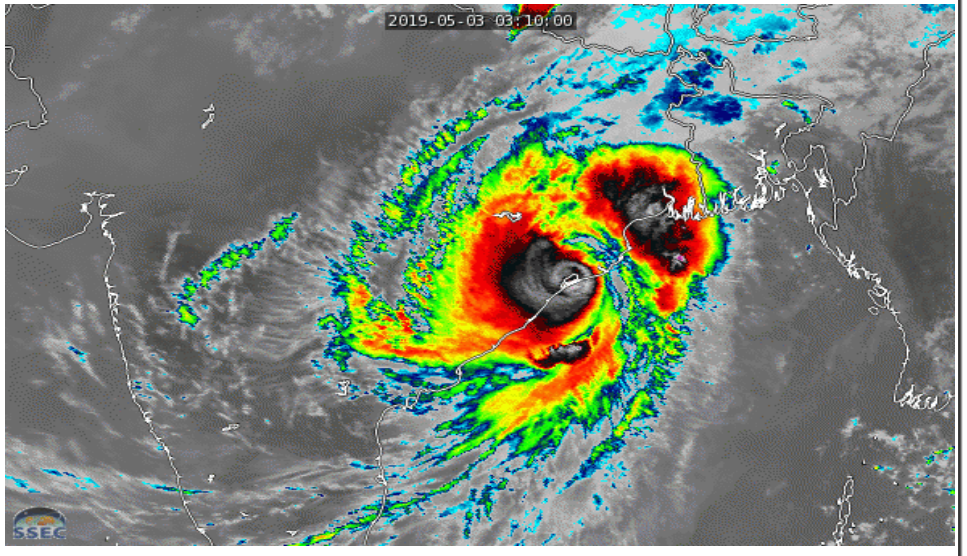
Crop damaged due to cyclone

Cyclone

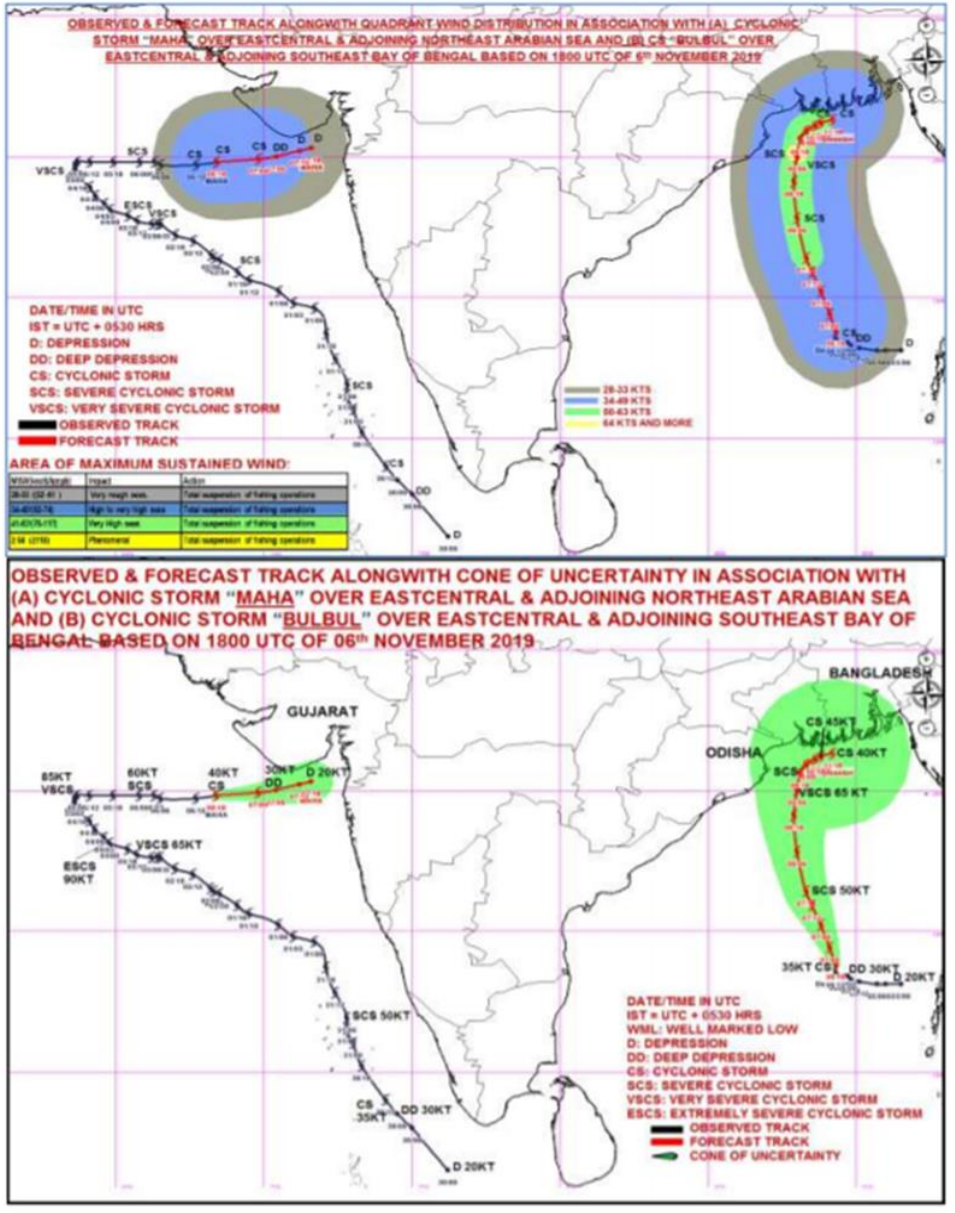
The observed and forecast track of cyclone ‘PHAILIN’ based on 1200 UTC of 9 October 2013.



Fani



Track of Bulbul as on 06 November 2019



Substantial Risk Reduction is possible today due to accurate track forecast and point of landfall well in advance

Impact of cyclone on agriculture

- **Losses of cash crops.**
- **Direct loss of fruits and mechanical damage to the horticultural crops, coffee and banana.**
- **Winds which blow from coastal seas spray a lot of salt on coastal areas, making it impossible to grow crops sensitive to excessive salt.**
- **Fields inundated by the storm surge suffer a loss of fertility due to salt deposition, even after the sea water has receded. The affected land takes a few years to regain its original fertility.**

HEAT WAVE

- Heat waves are defined under two categories. The first category includes places where the normal maximum temperature is more than 40°C. In such regions if the day temperature exceeds by 3 to 4°C above the normal, it is said to be affected by a heat wave.
- Similarly, when the day temperature is 5°C or more than the normal, severe heat wave condition persists. The second category considers the regions where the normal maximum temperature is 40°C or less.

Heat Wave damage to Mango Orchard

Custard Apple is tolerant to High temperatures

Heat Wave

- In regions where the normal maximum temperature is more than 40^0C, if the day temperature exceeds 3-4^0Cabove normal for 5-6 days it is defined as heat wave. Similarly, in regions where the normal temperature is less than 40^0C, if the day temperature remains 5-$6^0$0C above normal for 5-6 days, it is defined as heat wave.

- Generally affected crops due to heat wave are wheat, mustard, rapeseed, linseed and vegetables.

wheat crop damaged due to extreme heat

Animal Husbandry

- Due to high temperature forecast, grazing /feeding of cattle/goats may be done during morning/ evening hours.
- Keep animals under shade/shed during noon hours and provide plenty of water mixed with minerals for drinking.
- Also provide balanced feed & adopt vaccination schedule.
- Make arrangement of curtains and proper ventilation in poultry house.
- .

Impact of heat stress on livestock production parameters

Meat yield and quality

Milk yield and quality

Feed intake and Nutrient utilization

Fertility, semen quality

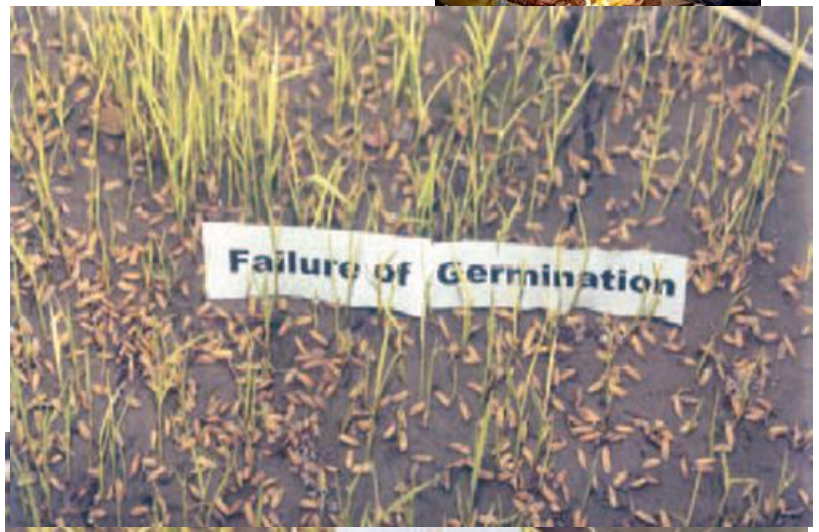
Mortality & morbidity

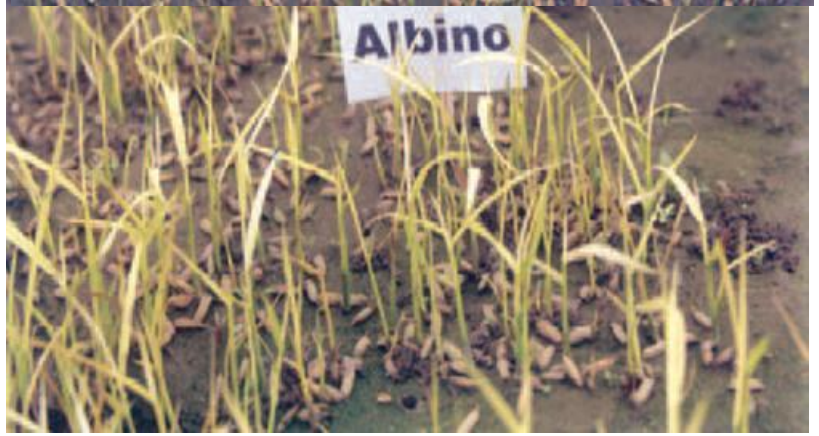
Under heat stress conditi on

COLD WAVES

- Cold Waves are incursion of dry cold winds coming from North direction and are associated with passing western disturbances.

- Low temperature decrease the number of sprout lets per tuber and the total sprout length per tuber and ultimately decrease the yield of potato.





Effects of cold injury in *boro* rice nursery bed in Assam in 2003

Cold Wave

- In regions where normal minimum temperature remains 10^0C or above, if the minimum temperature remains 5-6^0C lower than normal continuously for 3 days or more it is considered as cold wave. Similarly in regions with normal minimum temperature is less than 10^0C, if the minimum temperature remains 3-4^0C lower than normal it is considered as cold wave
- Mostly horticultural crops are affected by cold wave

Impact Cold wave on wheat crop

Impact of Extreme cold weather / frost

- ✓ Loss of winter crops, fruit crops and vineyards due to frost injury.
- ✓ Low soil temperature at the depth of plant roots cause frost injury.
- ✓ Frost damage in winter crops due to low soil temperature at the depth of the tillering node.
- ✓ Long (three days or more) and intensive cooling causes complete devastation of the crops.
- ✓ Cooling to the critical temperature of frost injury, even for one day, and especially after a thaw, results in thinning out of crops.

Advisories for Cold wave Conditions

- Advised to arrange for smoking around the fields during night.
- Apply light and frequent irrigation /sprinkler irrigation in the evening to protect the crops from frost / cold injury.
- To protect young fruit plants from chilly winds, cover young fruit plants with straw/polythene sheets/gunny bags.
- Cover nursery bed of tomato with gunny bags to protect form cold .

Animal Husbandry

Cold wave conditions

- Keep the animals inside the sheds and provide dry bedding and use heaters inside cattle sheds to protect them from cold.
- Increase protein level and minerals in the feed concentrate to keep the animals healthy to cope up with the situation.

Poultry

- Keep the chicks warm by providing artificial light in the poultry sheds.

Frost damage to the different crops (Hisar)

Hailstorm

Care and advisory for management of hail affected crops

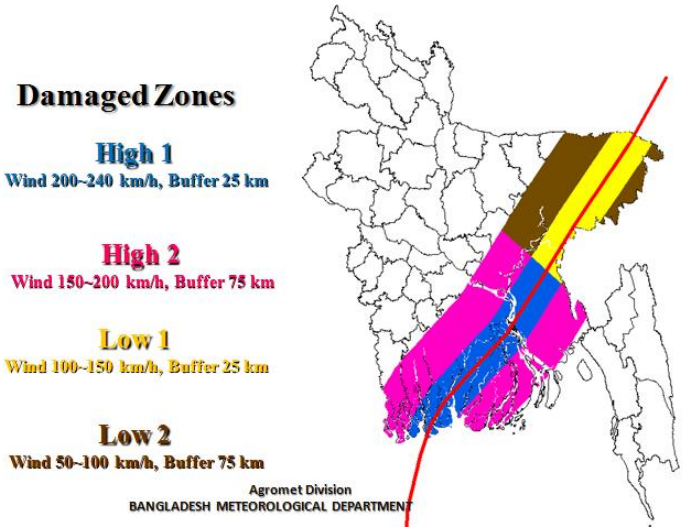
- To clean up the debris and fallen fruits from orchards and trim off broken stems and leaves of plants to avoid further spread of pest and diseases.
- If crop has not been fertilized, an application of fertilizer to the impacted plants can help them to re grow and develop new foliage. Remove damaged fruits, which will attract insects.
- Injuries to trees that are minor will heal but benefit from an application of fungicide to prevent rot from entering before the wounds are able to seal.
- Open wounds on the growing shoots, branches and scaffolds present entry points for bacterial and fungal pathogens and also insects.
- Plants damaged in the spring season benefit from a layer of mulch around the base of the plant to help it survive summer.
- Some plants are too heavily affected and fixing hail damage is not possible. These plants should be removed and replaced with new plants.

Damages of Crops due to extreme events

Brown Plant Hopper on paddy in Rangpur District

Brown Plant Hopper on paddy in Magura

Crop loss due to Bulbul



Crop damage assessment from cyclone SIDR

. **Damages caused by the recent cyclone Phailin**

Crop loss due to heavy rain & strong wind in Maharashtra, India

What's happening now?

Global Climate change is seriously affecting water cycle, which causes..

Damage to Agricultural productivity, and Human Health.

Space-born observation will help to make countermeasure strategy.

What we can observe by satellites.

- CO2 observation
- precipitation observation
- Meteorological observation
- vegetation observation
- Biomass observation
- Soil moisture Land water
- cropping, etc.

What is Remote Sensing?

Remote sensing is acquisition of data for deriving information about objects or materials (targets) located at the Earth's surface or in its atmosphere by using sensors mounted on platforms located at a distance from the targets.

Here measurements are made in different spectral regions on interactions between the targets and electromagnetic radiation (EMR). The field of remote sensing encompasses techniques that obtain precise information about earth's surface from a distance.

The advent of satellites is allowing the acquisition of information about the Earth and her environment. Sensors on the near-polar orbiting Earth resources and weather satellites provide information over 113 - 185 Km and 2950 Km wide region respectively about –

- Patterns and dynamics of clouds
- Surface vegetation cover and its seasonal variations
- Surface morphology
- Sea surface temperature, wave heights and
- Near sea surface wind

Remote Sensing Observation Platforms

Remote sensors can be grouped into two major categories –

(1) passive sensors

(2) active sensors

Sensors which sense natural radiation either emitted by or reflected from the earth's surface are called passive sensors. Thus in passive sensing systems, there is no control over the source of electromagnetic radiation. The examples of passive remote sensors are photographic cameras, multispectral scanners, vidicon cameras etc.

The sensors which have their own source of EMR for illuminating the objects are called active sensors. Examples for active sensors are RADAR (Radio Detection and Ranging), LIDAR (Light Detection and Ranging) etc.

The platforms which are in use in remote sensing of earth resources are –

(a) Airborne platform

(b) space-borne platform

Different stages in remote sensing can be broadly entitled as :-

- A source of electromagnetic energy (Sun/self emission).
- Transmission of energy from the source (Sun) to the surface of the earth wherein it also undergoes absorption and scattering during passage through the atmosphere.
- Interaction of EMR with the earth's surface (reflection, scattering, absorption and reemission).
- transmission of reflected / scattered / emitted energy from the objects / features of earth's surface to the remote sensors (with due modification due to atmospheric effects).
- sensor data output.

APPLICATION AREAS

Agriculture

Acreage estimation
Crop yield forecasting
Crop condition assessment
Cropping systems analysis
Vegetation Dynamics

Land & Soil

Salt affected soils mapping
Land degradation analysis
Soil resource mapping
Soil suitability analysis
Support to Soil moisture estimation

Water Resources

Ground water potential zones
Surface water inventory
Tanl/well command area studies
Drought impact assessment on crop yield

Hydrology

Flood damage information and management
Drought monitoring

Satellite Data & Agrometeorology

- Satellite offer a unique source of information for many agricultural applications.
- Recent advances in satellite technology in terms of high resolution , multi-spectral bands provide useful information for agricultural operations
- Integrated use of satellite data and conventional meteorological observations is found to be very useful to extract information relevant to agriculture in India.

Retrieval of Agrometeorological Parameters using Satellite Data

- Meteorological satellites play an important role in retrieval of the following parameters.
- Cloud
- Rainfall
- Soil Moisture
- Solar radiation
- Surface Temperature
- Brightness temperature
- Temperature and humidity profile

Area of RS Applications in AgroMet

- Soil (Moisture, temp., Nutrient, Erosion)
- Crop (Coverage, vigor, yield assessment)
- Crop sowing/Harvesting Time
- Forest Status Monitoring & Forest Fire
- Bio-diversity Assessment
- Mapping Of Ag. & Land Resources
- Biotic & Abiotic Stresses On Crops
- Pest Disease Surveillance

We need to develop RS based products which can assist in selecting sowing/harvesting time, scheduling irrigation, nutrient management, P&D management, intercultural operations, beside defining the initial condition of the atmosphere for NWP models.

Agromet. Products from NOAA/MODIs/Metops and GPS

- Land Surface Temperature
- NDVI
- Firest Fire
- FOG
- Surface emissivity
- IPWV

AAS (Agromet Advisory Services) Application areas

- Ground Truth on Soil, Crop, P&D, Stress (Moisture/Thermal/Nutrient/Biotic) while Translating Wx F/C into AgroAdvisory (Pre-sowing to Post Harvest)
- Decision on intercultural operations (Water, nutrient, pest-disease management)
- Quantifying Agricultural Risks – insurance
- Impact of extreme events on crops (Heat, Cold, Frost, Hail)
- Drought & Flood Related Advisories
- Contingent Planning (based on soil moisture & rainfall anomaly)
- Agro-climatic zoning
- Soil erosion zoning, its revision for better future planning
- Agro-Hydrological Options

CROP ACREAGE ESTIMATION

- **The first step in using Remote Sensing for acreage estimation is to identify crop cover by Remote Sensing, For this reason, one must study the reflectance characteristics of green leaf.**

- **Remote Sensing based preharvest acreage estimation methodology for major crops like paddy, wheat, cotton, soybean, sugarcane, sorghum etc. are well established.**

The classification strategies are

1) Minimum-Distance-to-Means classifier

(2) Parallelepiped classifier

(3) Gaussian Maximum likelihood classifier

CROP CONDITION / STRESS ASSESSMENT

- **Crop vigour / condition is affected by several factors such as supply of water and nutrients, insect and pest attack, disease outbreak and adverse weather conditions which cause physical / physiological changes and alter the spectral characteristics of crop canopy.**

- **Several Remote Sensing approach are developed for crop condition assessment. In optical Remote Sensing involving reflective spectral bands, crop condition Assessment are done by studying Vegetation Index Anomaly.**

IMPORTANT SPECTRAL VEGETATIVE INDICES

Simple Difference Index (SDI)

$$SDI = IR - R$$

This provides a better estimate of LAI and biomass than either band alone. But it is not independent of the effects of variable solar angle and azimuth.

Ratio Vegetation Index (RVI)

$$RVI = IR/R$$

Normalised Difference vegetation Index (NDVI)

$$NDVI = (IR - R)/(IR + R)$$

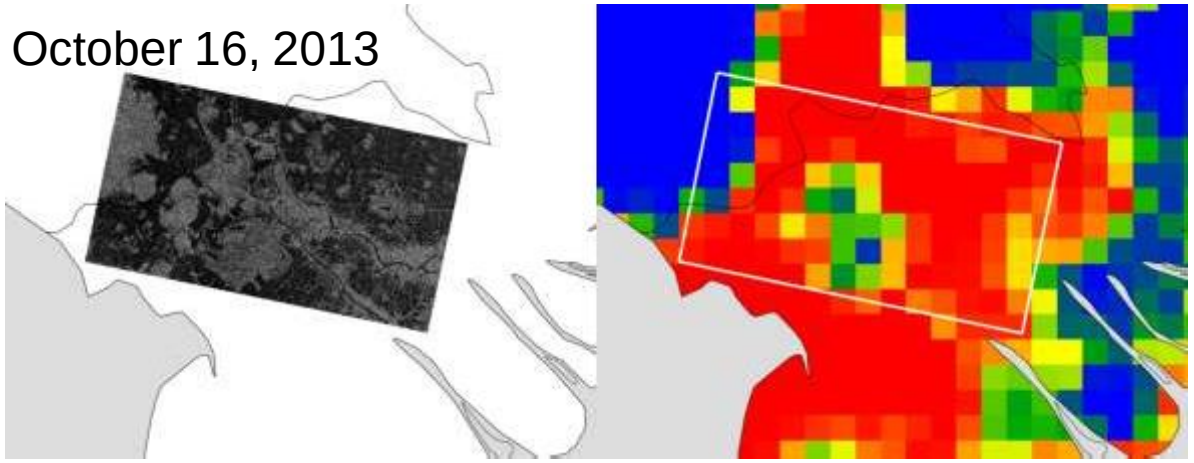
Perpendicular vegetation Index (PVI)

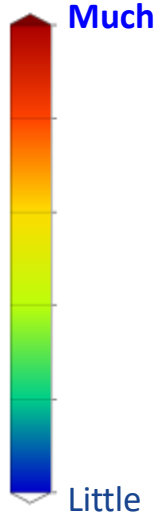
$$PVI = [(Rsoil - Rveg)2 + (IRsoil - IRveg)2]1/2$$

It estimates the effect of soil. Increasing vegetative development decreases the red reflectance and increases IR reflectance.

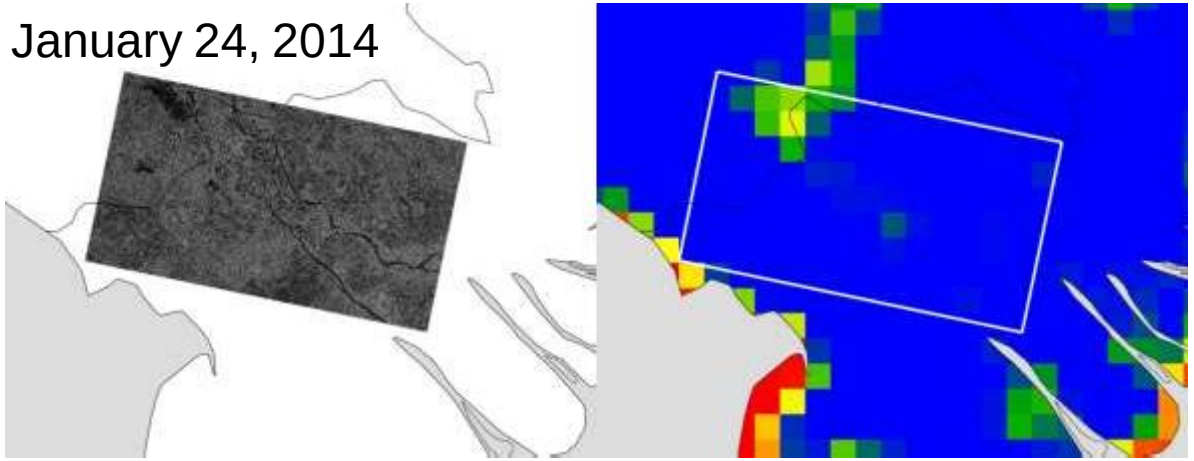
Validation of flood information

- This is an example of validation using RADARSAT-2 SAR data in Vietnam
- Comparing land water index map and SAR (synthetic aperture radar) data

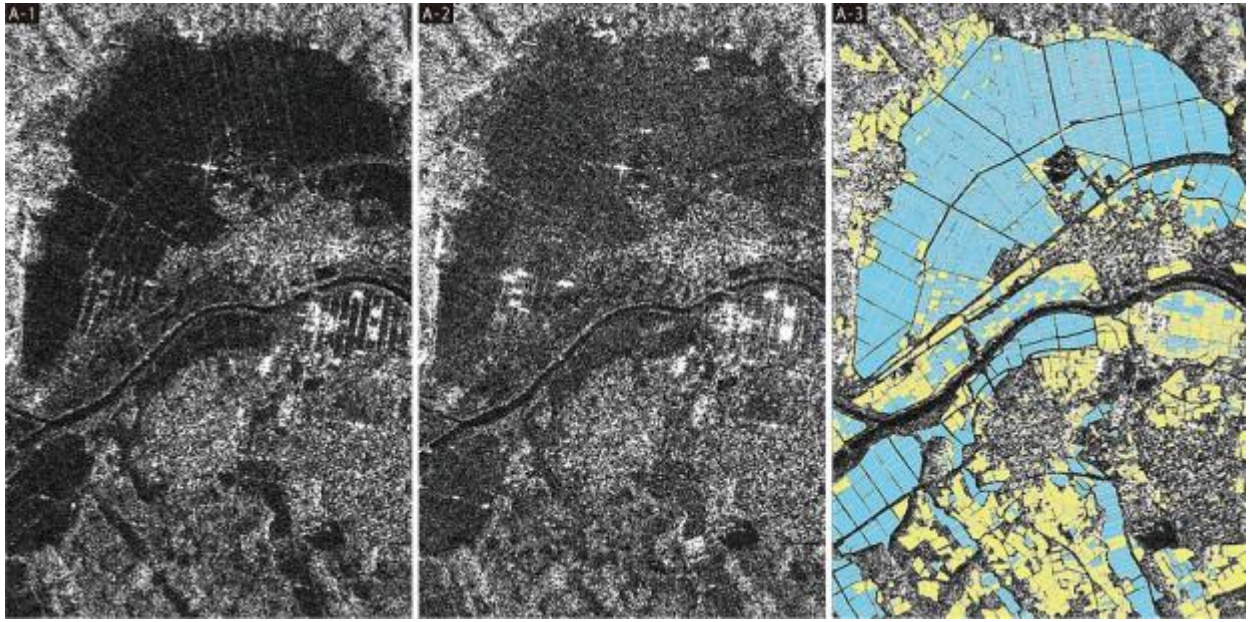




The dark portions of the SAR image represent water on the land surface.



Using Satellite Data to Vitalize Agriculture and Solve the Problem of Food Shortages- Remote sensing technology of Japan



Accuracy and Transparency of Information Are Required for the Stable Supply of Food

This is an image of rice fields taken with a microwave sensor from an earth observation satellite. Image (A-1) appears dark before planting. It retains its dark appearance for some time after planting (A-2), but as the crops grow the image becomes brighter. The rice field map (A-3) has been completed by analyzing the images from these two seasons. The blue indicates paddy rice, and the yellow indicates other plants.

Monitoring of Pests & Diseases from Satellite Data

❖Remote sensing tool is used for monitoring of large areas frequently

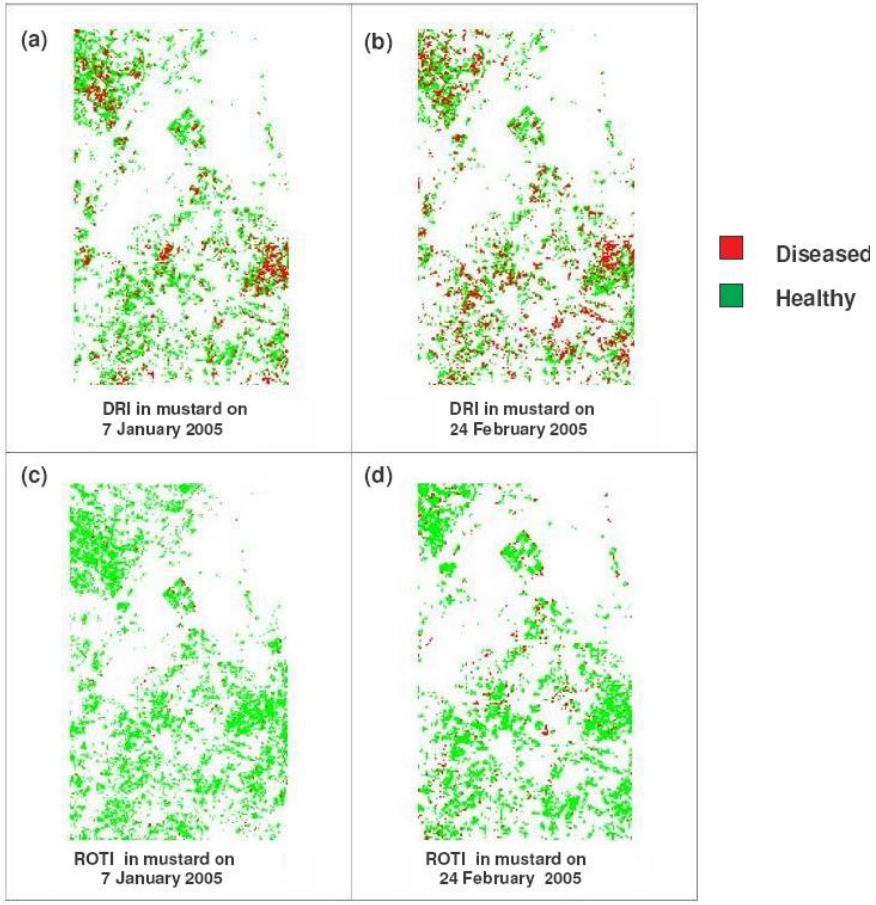
❖The earth observing systems are useful in monitoring weather and ecological conditions favorable for pests and diseases.

❖Among the weather parameters remotely sensed and most easily retrievable and used for disease prediction are:

❖Type of cloud

❖Extent of cloud cover

❖Cold cloud duration



Assessment and Monitoring of Soil Erosion using RS

- The potential utility of remotely sensed data in the form of aerial photographs and satellite sensors data has been well recognized in mapping and assessing landscape attributes controlling soil erosion, such as physiography, soil, land use/land cover, relief, soil erosion pattern
- Remote sensing can facilitate studying the factors enhancing the process, such as soil type, slope gradient, drainage, geology and land cover.
- Multi-temporal satellite images provide valuable information related to seasonal land use dynamics.
- Satellite data can be used for studying erosional feature, such as gullies, rainfall interception by vegetation and vegetation cover

Remote sensing and Drought Monitoring

- Drought condition can be monitored using data obtained from satellite.
- Satellite sensors are capable of discerning physiognomic changes of vegetations trough spectral radiance measures and manipulation of such measures into vegetation indices, which are sensitive to the rate of plant growth as well as to the amount of growth.
- The visible and near infrared bands on the satellite multispectral sensors allow monitoring of the greenness of vegetation.
- Capability od satellite-borne sensors to provide information on various drought indicators to monitor drought effectively is well documented in recent past.

Identification of Fishing Zone

- Remote sensing methods help greatly in optimisation of ocean resources.
- Several parameters relating to the oceans including fisheries is studied using satellite.
- One of the important parameters that can be measured with sufficient accuracy is the Sea Surface Temperature(SST) which is related to the concentration of fish population.
- SST derived from NOAA-AVHRR satellite serves as avery useful indicator for fish aggregation.
- Based on the thermal features location of potential fishing zones are being identified.

Using Satellite Technologies to Protect African Farmers from Climate Shocks In sub-Saharan Africa[

Climate shocks such as drought frequently cause crop loss and livestock death across the continent, sending large parts of the population into turmoil. A changing climate is expected to make the situation worse.

By using satellite information and data collected on the ground, focus is shifting from reacting to disasters after they occur ("ex post"), to pre-planning the response ("ex ante"). This vastly speeds up the response, as satellites provide an immediate first impression of the situation without conducting a lengthy needs assessment. As soon as the satellite picks up a drought, response measures can be launched, bringing help rapidly to those who need it most.


THANK YOU