Agriculture Decision Support System (AgriDSS)

A Geospatial Implementation of Drought Manual 2020

Drought is a temporary abnormality that is permanent in nature. Understanding the dire effects of drought on agriculture, water resources and social-economic conditions, Government of India has prepared Drought Manual-2020. Its objectives include defining roles and responsibilities of stakeholder agencies and effective coordination; scientific rational based drought assessment and time bound completion of drought assessment process.

Keeping in the mind above views, VEDAS, in association with other collaborating agencies, has developed **Agriculture Decision Support System** (**AgriDSS**) as geospatial implementation of drought manual. This portal follows the drought declaration procedure inscribed in drought manual in a very user-friendly manner. The maps of various stages of drought declaration along with status of mandatory and impact indicators can be geo-visualized and analysed on this portal. The drought status data is aggregated on district and taluka level. It is presented in graphical, tabular and map form for easy understanding and on the web data analysis. This platform provides end-to-end solution from data visualization of different indexes to report generation with a few clicks. This automated system provides real time and web based monitoring accessible at any time and from anywhere in the world. The primary advantages of AgriDSS are scientific and objective drought assessment minimizing human intervention and errors, and reducing data preparation time giving enough time for decision-making and field surveys. The user can access this system through web by visiting the URL: https://vedas.sac.gov.in/agridss/index.html .

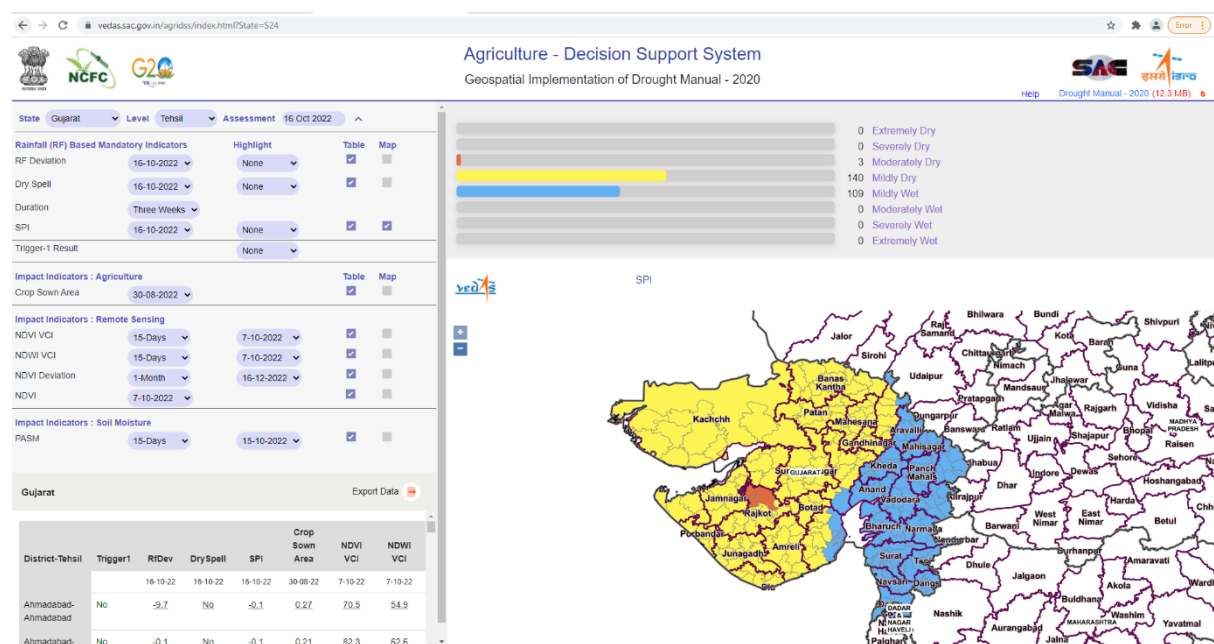## Functionalities and Salient Features
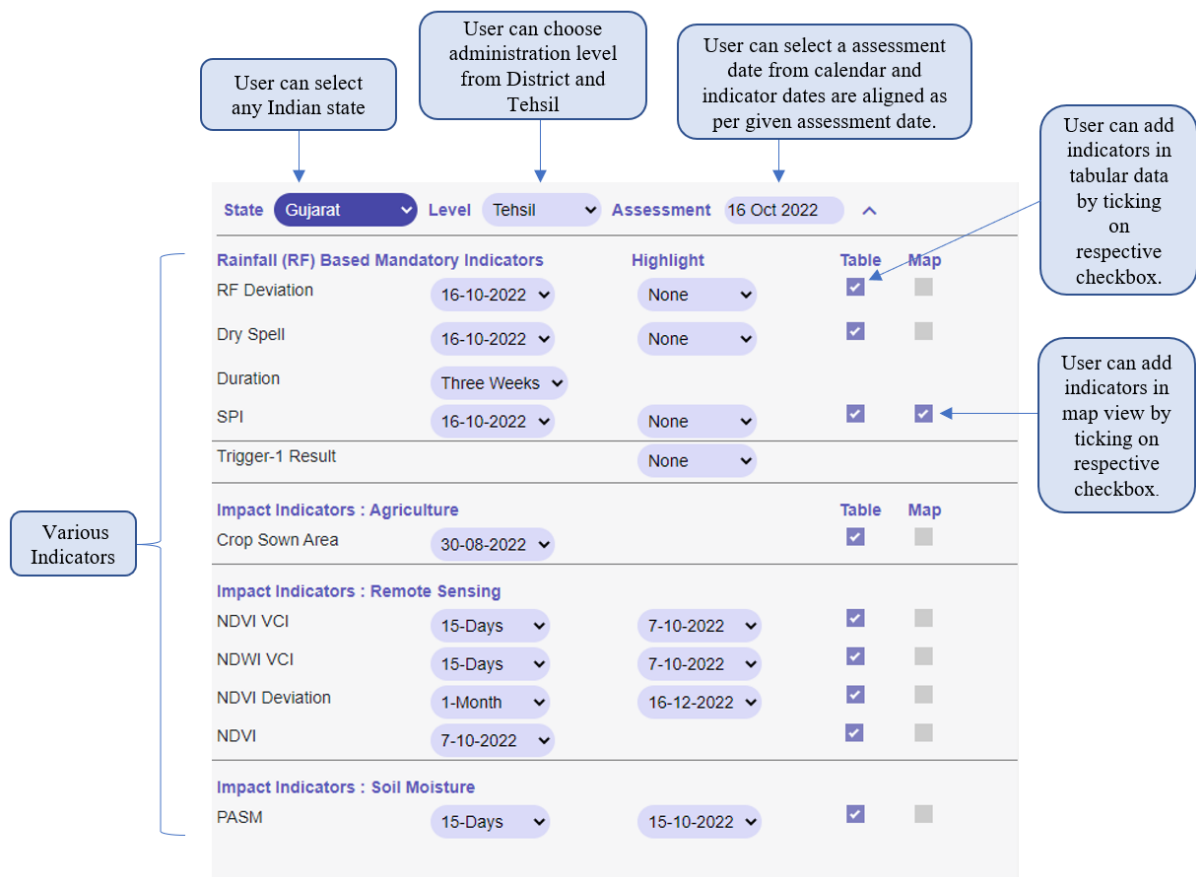

Figure 1: Screenshot of Agriculture-Decision Support System
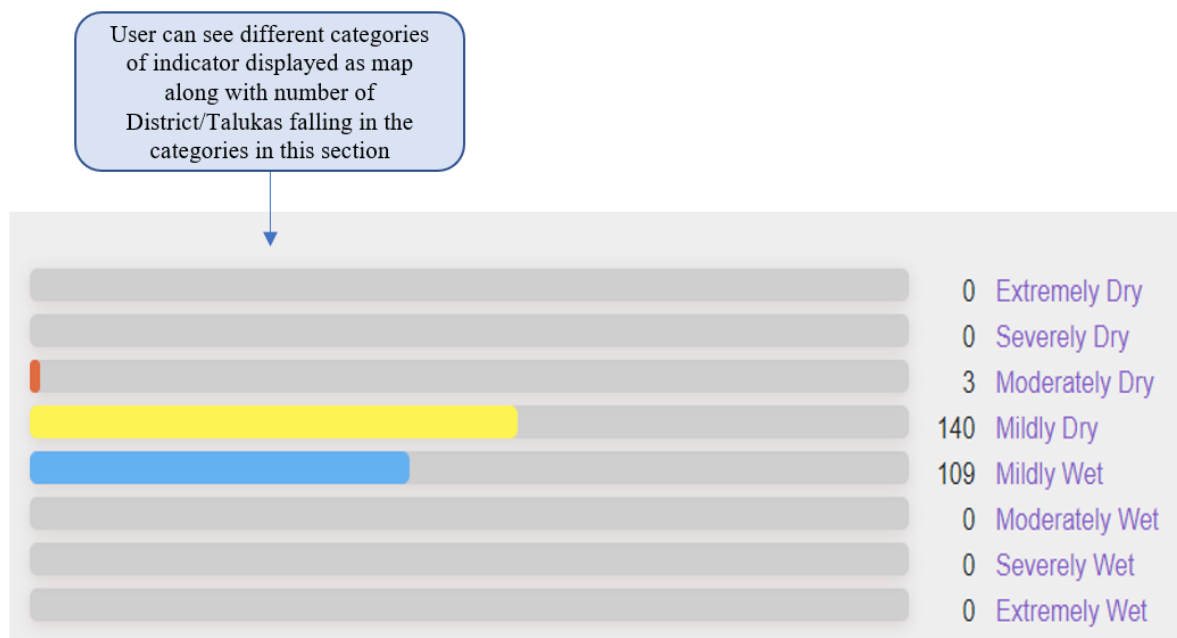
Figure 2: Screenshot of indicators selection panel

Figure 3: Categories of selected indicator to be shown as map

Gujarat

Export Data

District-Tehsil	Trigger1	RfDev	Dry Spell	SPI	Crop Sown Area	NDVI VCI	NDWI VCI
		16-10-22	16-10-22	16-10-22	30-08-22	7-10-22	7-10-22
Ahmadabad-Ahmadabad	No	-9.7	No	-0.1	0.27	70.5	54.9
Ahmadabad-Bavla	No	-0.1	No	-0.1	0.21	82.3	62.6
Ahmadabad-Daskroi	No	-10.1	No	-0.0	0.75	84.5	66.1
Ahmadabad-Detroj	No	-0.2	No	-0.1	0.14	69.8	34.9
Ahmadabad-Dhandhuka	No	0.1	No	-0.1	0.24	75.4	58.2
Ahmadabad-Dholera	No	-1.3	No	0.1	0.05	64.7	41.2
Ahmadabad-Dholka	No	-2.7	No	-0.0	0.34	82.9	58.4
Ahmadabad-Mandal	No	9.0	No	-0.2	0.07	71.9	44.3
Ahmadabad-Sanand	No	-3.2	No	-0.1	0.38	86.1	72.2
Ahmadabad-	No	2.1	No	-0.2	0.04	81.2	56.9

Figure 4: Categories of selected indicator to be shown as map

Figure 5: Map view of different categories of selected indicator

Data Sources

Satellite/Product	Spatial Resolution	Temporal Resolution	Indices Generated (as per Drought Manual)	Remarks
Terra MODIS (MOD13Q1)	**250m**	**16 Days**	**Vegetation Indices:** 16-Days Max Composite NDVI, NDWI and Vegetation Condition Index (VCI)	Terra MODIS captures earth's surface daily in 36 spectral bands in morning.
GSMAP	**0.1º**	**Daily**	**Rainfall Indices:** Rainfall Deviation, Dry Spell, Standard Precipitation Index (SPI)	GSMAP is global multi satellite mission generating precipitation map from geostationary satellites using Dual-frequency Precipitation Radar (DPR).
SMAP	**0.125º**	**Daily**	**Soil Moisture Index:** Percentage Availability Soil Moisture (PASM)	SMAP or Soil Moisture Active Passive mission maps water in the soil on earth using satellite.
Sentinel-2(A/B)	**10m**	**5 Days**	**Crop Sown Area**	Sentinel-2 is high resolution optical satellite capturing earth in 13 bands including VNIR and SWIR.

Table 1: Data Sources of AgriDSS

Indicators of Drought

1. Mandatory Indicators

1.1 Rainfall Deviation

The rainfall deviation (RFdev) which is expressed in percentage terms is calculated as below:

$$RFdev = ((RFi – RFn)*100/RFn)$$

where RFi is current rainfall for a comparable period (in mm) and RFn is the normal rainfall (at least 30 years average) for the same period (in mm). Below Table-2 depicts drought categories based on RFdev values.

Deviation from Normal Rainfall	Category
+19 to -19	Normal
-20 to -59	Deficient
-60 to -99	Large Deficient
-100	No Rain

Table 2: Categories of Rainfall Deviations (IMD)

1.2 Dry Spell

A dry spell is a short period, usually 4 weeks (up to 3 weeks in case of light soils), of low rainfall or no rainfall. Thus, consecutive 3-4 weeks after the due date for the onset of monsoon with rainfall less than 50% of the normal in each of the weeks is defined as a Dry spell.

1.3 Standardized Precipitation Index (SPI)

It expresses the actual rainfall as a standardized departure with respect to rainfall probability distribution function where the positive SPI indicating greater than median precipitation and negative values indicating less than median precipitation.

SPI can be ideally calculated on the basis of a minimum of 30 years of historical data for a station. SPI should be computed only for the monthly time scale. The SPI based categories are as shown in Table 3.

SPI Value	Category
<-2	Severely Dry
-1.49 to -1.0	Moderately Dry
-0.99 to 0	Mildly Dry
0 to 0.99	Mildly wet
1.0 to 1.49	Moderately wet
1.5 to 1.99	Severely wet
>2.0	Extremely wet

Table 3: Standardized Precipitation Index (SPI) Categories

2. Impact Indicators

2.1 Agriculture Indicator

2.1.1 Crop Sown Area

Drought conditions could be said to exist if the total sown area under kharif crops is less than 85% of the total normal sown area by the end of July/August, depending upon the schedule for

sowing in individual States due to failure of rains or very late arrival of monsoon. In such situations, even if rainfall revives in the subsequent months, there is little possibility of full recovery and the agricultural production is likely to take a substantial hit. However, the conditions will indicate portents for drought of a 'severe' nature, if the area under crops falls to 75% of the normal by the end of July / August. State Governments should, therefore, consider the status of coverage by the end of July/August to see if the shortfall in sown area is significantly short of the total normal sown area.

2.2 Remote Sensing Indicators

NDVI is derived using the formula (NIR – Red) / (NIR + Red), where NIR and Red are the reflectance in visible and near infrared channels in satellite image. NDVI is sensitive to the density and vigor of crops.

NDWI is derived using the formula (NIR-SWIR) / (NIR+SWIR) where, NIR and SWIR are the reflectance in Near Infrared and Shortwave Infrared channels in satellite image. Higher values of NDWI signify more surface wetness.

There are two derivatives from NDVI/NDWI to indicate the drought impact on croplands namely, (1) deviation index in percentage (NDVIdev) and (2) Vegetation Condition Index (VCI).

2.2.1 NDVI/NDWI Deviation

For computing NDVIdev, normal NDVI/NDWI is generated by averaging the NDVI/NDWI of at least 3 recent normal years.

NDVIdev = (NDVIi – NDVIn)*100/NDVIn
NDWIdev = (NDWIi – NDWIn)*100/NDWIn

Where subscript 'n' refers to normal value and 'i' to current period.

NDVIdev	Category
>-20	Normal
-20 to -30	Moderate
<-30	Severe

Table 4: Drought classes based on NDVIdev

2.2.2 Vegetation Condition Index (VCI) of NDVI/NDWI

The VCI compares the observed NDVI and NDWI to the range of values observed for the same period in previous years. The VCI is expressed in %age and gives an idea where the current value is placed within the extreme values (minimum and maximum) in the historical datasets normalized to a scale of 0 – 100%. Lower and higher values indicate bad and good vegetation state conditions, respectively. VCI is computed as under:

VCI (NDVI) = {NDVIcurr -NDVImin)/NDVImax-NDVImin)] * 100

$$VCI (NDWI) = \{NDWIcurr - NDWImin)/NDWImax - NDWImin)] * 100$$

VCI Value (%)	Vegetation Condition
60-100	Normal
40-60	Moderate
0-40	Severe

Table 5: Classification of Vegetation Condition based on VCI value

2.3 Soil Moisture Indicators

2.3.1 Percentage Availability Soil Moisture

PASM is derived from observed moisture sensor data or sample soil-water balance model following the 'bucket approach' and using the following formula:

$$PASM = [(SMd - PWP) / (FC - PWP)] * 100$$

where SMd is the aggregated volumetric soil moisture (vol/vol) for the current duration, FC is the field capacity of soil (vol/vol) and PWP is the permanent wilting point of the soil (vol/vol).

Soil Moisture Index: Soil Moisture Index (SMI), which gives an idea where the current value of soil wetness is placed within the extreme values (minimum and maximum) in the historical datasets normalized to a scale of 0 – 100. The SMI is used as surrogate indicator of Percentage Available Soil Moisture (PASM).

PASM (%)	Agriculture Drought Class
76-100	No drought
51-75	Moderate drought
0-50	Severe drought

Table 6: PASM/SWI based Categories

2.4 Hydrology Indicators

The hydrology-based indicators will be updated soon on AgriDSS portal.

Process for the determination of Drought

The following steps are suggested for the determination of drought:

Step 1: Mandatory Indicators viz. RF deviation or SPI or Dry Spell will be considered as per matrix at Table 7 to assess if the first drought trigger is set off.

RF Dev/SPI	Dry Spell	Drought trigger
Deficit or scanty rf/SPI<-1	Yes	Yes
Deficit or scanty rf/SPI<-1	No	Yes if rainfall is scanty or SPI<-1.5, else No
Normal rf/SPI>-1	Yes	Yes
Normal rf/SPI>-1	No	No

Table 7: Matrix for Mandatory Indicators (Trigger-1)

Step 2: In the event that the first drought trigger is set off in Step 1, the Impact Indicators will be examined as per the matrix at Table 8.

Mandatory Indicators		Impact Indicators				Category of drought
Rainfall Indices		**Agriculture**	**Remote Sensing**	**Soil Moisture**	**Hydrology**	
Rainfall Deviation (RFdev) or SPI	Dry Spell	Crop Sown Area	VCI or NDVI & NDWI Deviations	PASM / MAI	SFDI / RSI / GWDI	

Table 8: Matrix for Impact Indicators (Trigger-2)

The States may consider any three of the four types of the Impact Indicators (one from each) for assessment of drought, the severity of the calamity and make a judgement.

Explanation:
The severity of the drought will be contingent upon the values of at least three out of four Impact Indicators viz, Agriculture, Remote Sensing, Soil Moisture and Hydrology in the following manner:

- Severe drought: If at least two of the selected 3 impact indicators are in 'Severe' category and one is in 'Moderate' category.
- Moderate drought: If at least two of the selected 3 impact indicators are in 'Moderate' category.
- Normal drought: for all other cases.
- Trigger 2 will be set off in the event of a finding of 'severe' or 'moderate' drought.
- *The State has an option to reduce the drought category by one rank (i.e. Severe to Moderate) if the irrigation percentage of the administrative region (District/Taluk/Block/Mandal), for which drought is being declared is more than 75%. However, in such a situation of reduction of drought intensity from 'Moderate'*

to 'Normal', the State Government will still be required to conduct field verification as prescribed in Step 3 below.

Step 3: In the event that Trigger 2 is set off **(severe or moderate),** States will conduct sample survey for ground truthing as described at 3.2.6 of Drought Manual-2020. The finding of field verification exercise (GT) will be final for judging the intensity of drought as 'severe' or 'moderate' depending on the crop loss.

In case, 80% of GT reveals crop loss of more than 50%, states have option to upgrade the intensity of drought from Moderate to Severe category.

The criteria for declaration of drought will be the same in case of consecutive droughts.