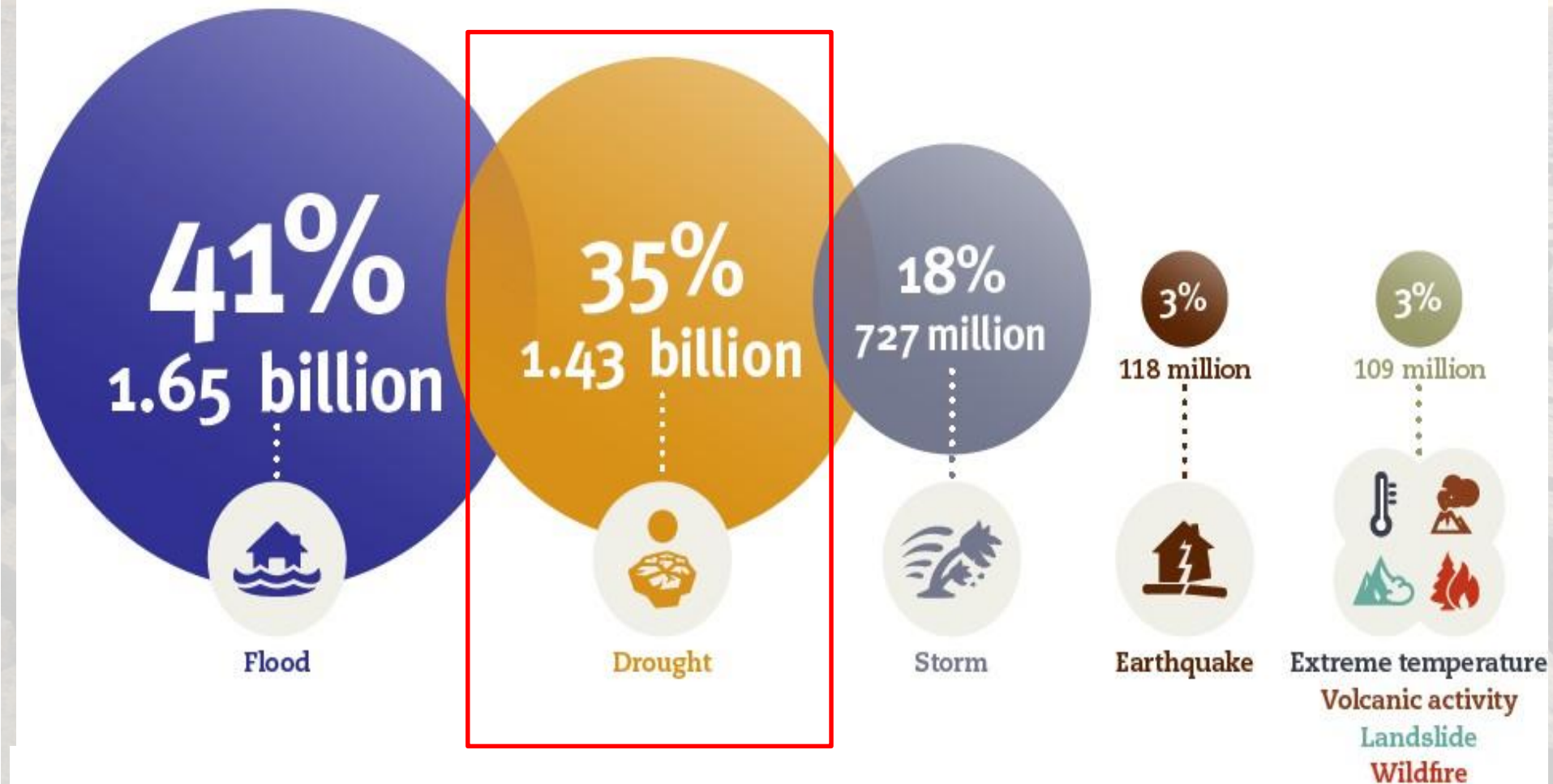# Multi-criteria modelling of drought: a study of Brandenburg Federal State, Germany

Global picture
People affected (2000-2019)

Total number of people affected
by disaster type (2000-2019)

41%
1.65 billion
Flood

35%
1.43 billion
Drought

18%
727 million
Storm

3%
118 million
Earthquake

3%
109 million
Extreme temperature
Volcanic activity
Landslide
Wildfire

Drought in Germany

According to the measurements of the **German Institute for Drought Monitoring (**Helmholtz Centre for Environmental Research), **Germany was affected by a historic drought event in 2018.**

Model the incidence of the 2018 drought in Brandenburg, Germany.

Research Objectives

❑ **Model the spatial variation of drought prevalence during the year 2018.**

❑ **Examine the intensity of the drought on agricultural land and food security.**

❑ **Suggest possible solution to improve drought monitoring and management.**
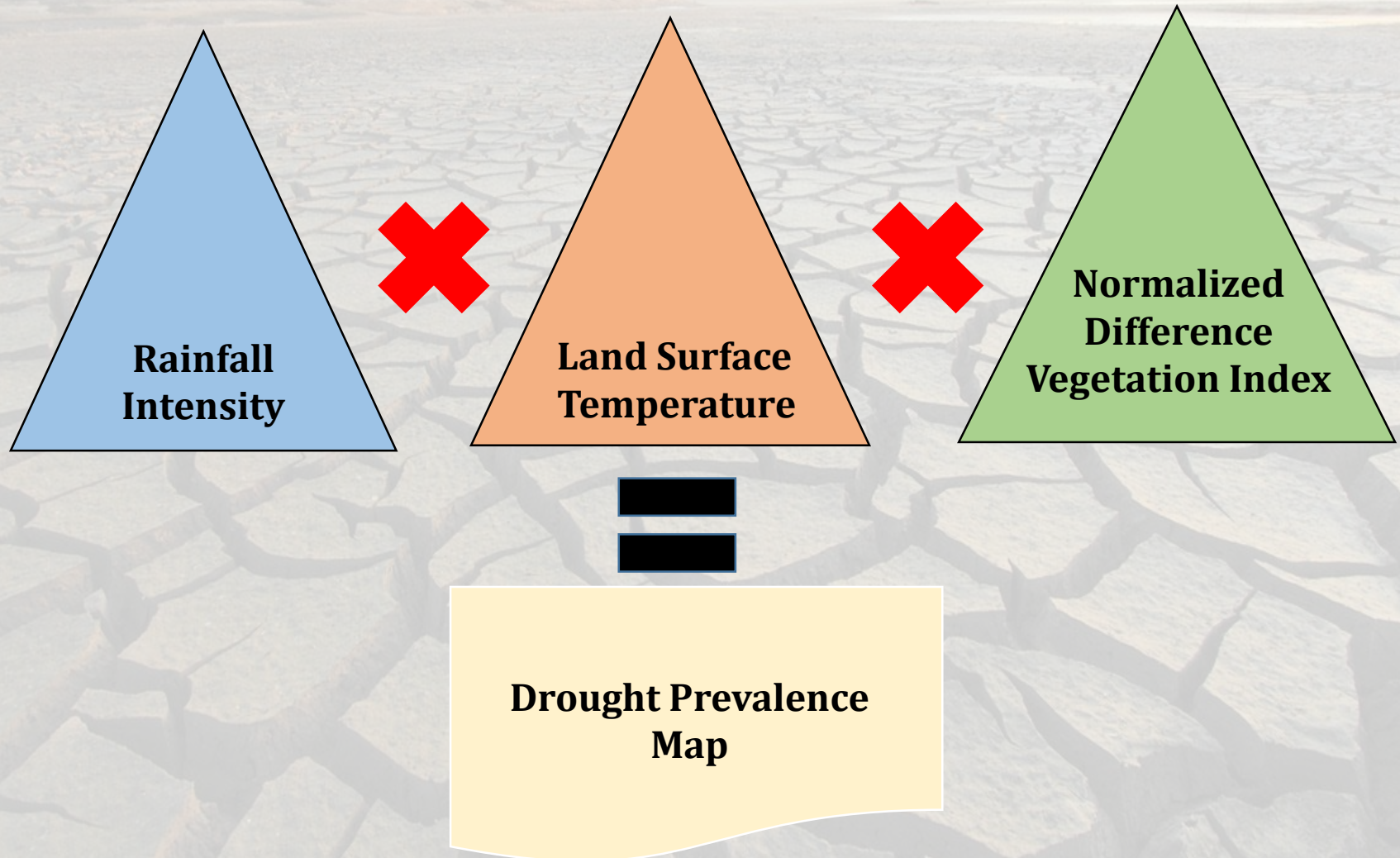
Brandenburg Federal State, Germany

- Located at the **North-East Germany.**

- Borders Germany's capital **(Berlin).**

- Occupies an area of **29,478skm.**

- One of the warmest region in Germany- **14 degree Celsius.**

- Mean Annual temperature is 10.9 Degree.

- **Precipitation** of less than **600mm.**

- **45%** of its area comprise of **Agricultural Land.**

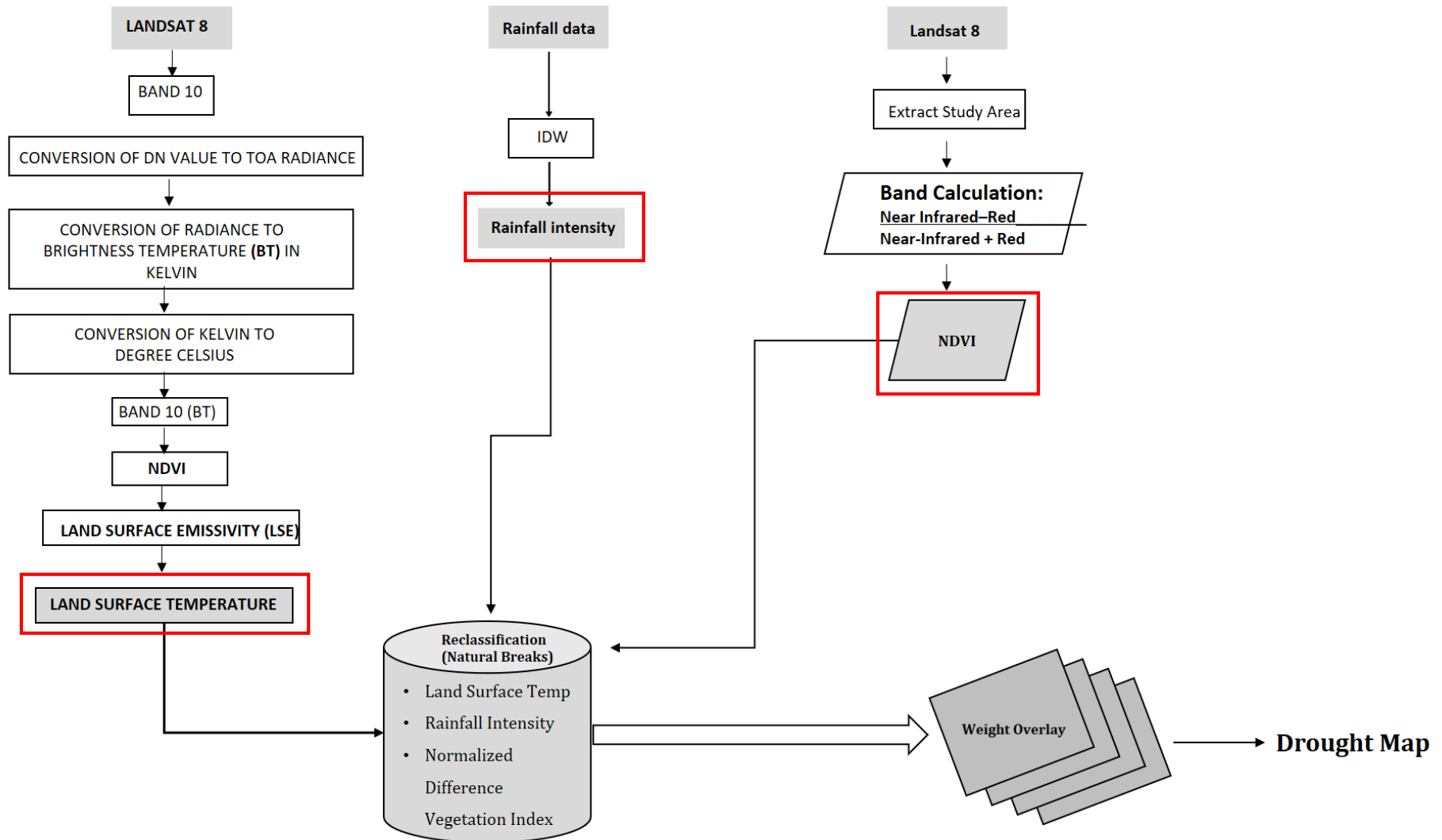- **77% Cropland and 23% Permanent grassland.**
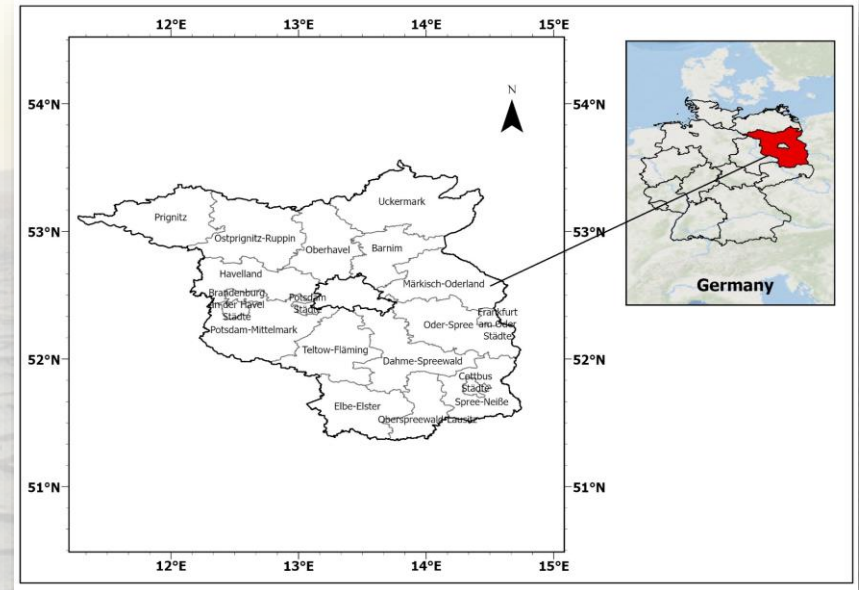
Droughts are characterized by complex interrelationships and therefore, like nature, can only be treated in a modelling fashion.

PLAN Model

Rainfall Intensity ✖ Land Surface Temperature ✖ Normalized Difference Vegetation Index

= Drought Prevalence Map

Source: Ihinegbu, C., Ogunwumi, T (2021)

Diagrammatical presentation Workflow

LANDSAT 8
↓
BAND 10
↓
CONVERSION OF DN VALUE TO TOA RADIANCE
↓
CONVERSION OF RADIANCE TO BRIGHTNESS TEMPERATURE **(BT)** IN KELVIN
↓
CONVERSION OF KELVIN TO DEGREE CELSIUS
↓
BAND 10 (BT)
↓
NDVI
↓
LAND SURFACE EMISSIVITY (LSE)
↓
LAND SURFACE TEMPERATURE

Rainfall data
↓
IDW
↓
Rainfall intensity

Landsat 8
↓
Extract Study Area
↓
Band Calculation:
Near Infrared–Red
Near-Infrared + Red
↓
NDVI

Reclassification (Natural Breaks)
- Land Surface Temp
- Rainfall Intensity
- Normalized Difference Vegetation Index
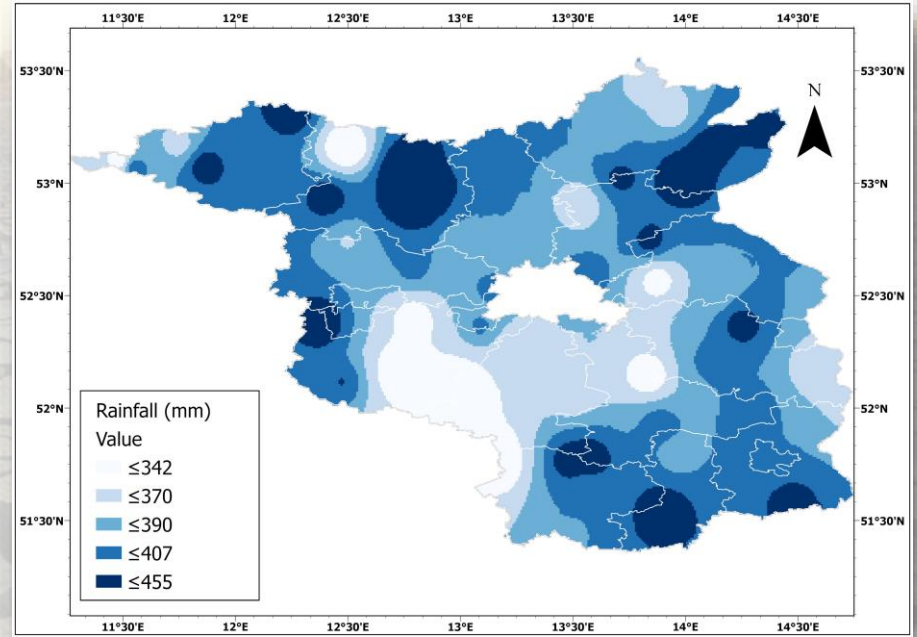
Weight Overlay

Drought Map

Rainfall Intensity

- Average annual rainfall recorded from **55 Weather Stations** in Bradenburg.

- Rainfall difference for the year 2018 compare to previous year (2016)

2016	2018
373mm – 633mm	288mm – 455mm

Source: Deutscher Wetterdienst 2020

- Decline in Rainfall intensity for year 2018
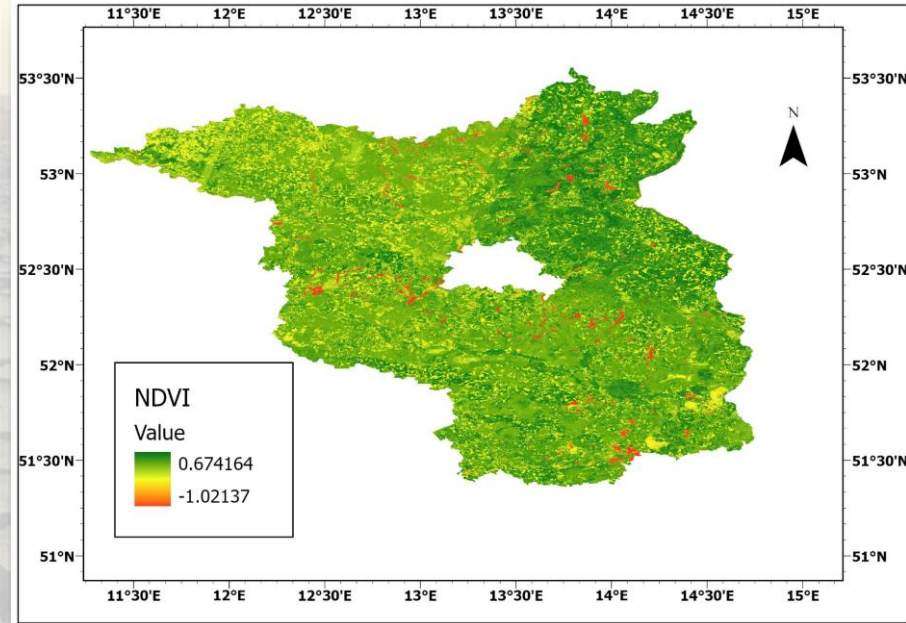

Precipitation distribution in Brandenburg for 2018

Land Surface Temperature

- Mapped using Landsat 8 Satellite Imagery. (Measure big areas quick and cheap)

- LST generated from Thermal band (Band 10) of Landsat 8.

- Its estimation depends on the albedo, vegetation cover and soil moisture of the object.

- Highest LS-temperatures were recorded in the Southern parts of Brandenburg.

Land Surface Temp Value
- ≤ 17.6
- ≤ 19.8
- ≤ 22.0
- ≤ 26.0
- ≤ 45.6
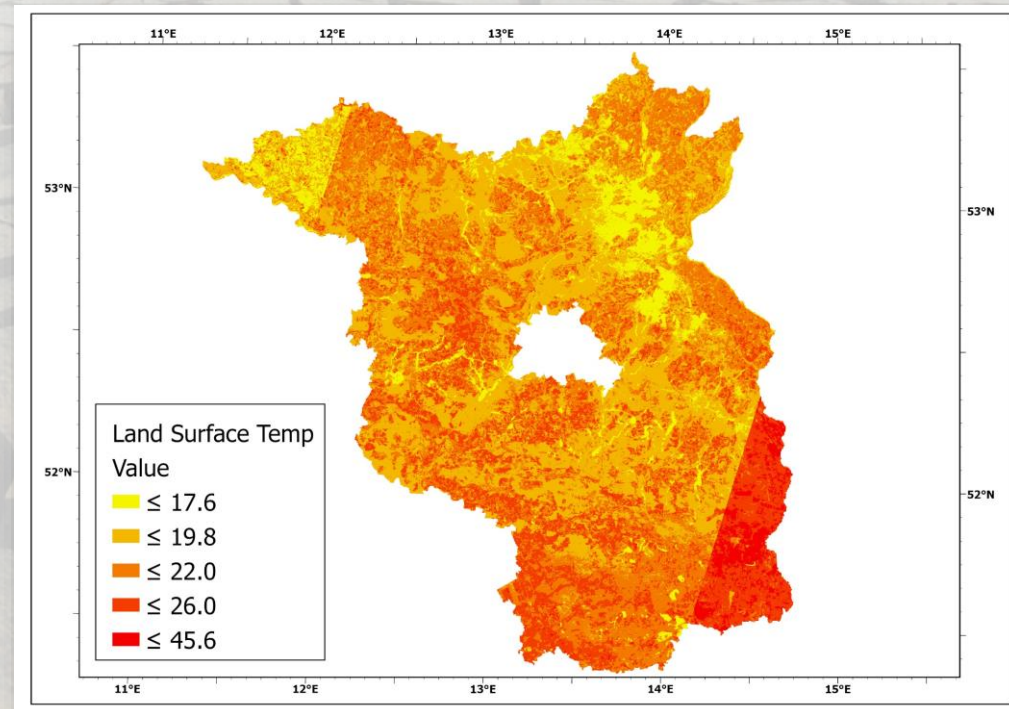
Normalized Difference Vegetation Index

- Mapped using Landsat 8 Satellite Imagery.

- The NDVI values range from − 1 to + 1. The negative limit value is highly like water, while the positive limit value indicates high vegetation health (dense green leaf).

- Diseased plants have less green leaf mass and thus lead to a lower NDVI.

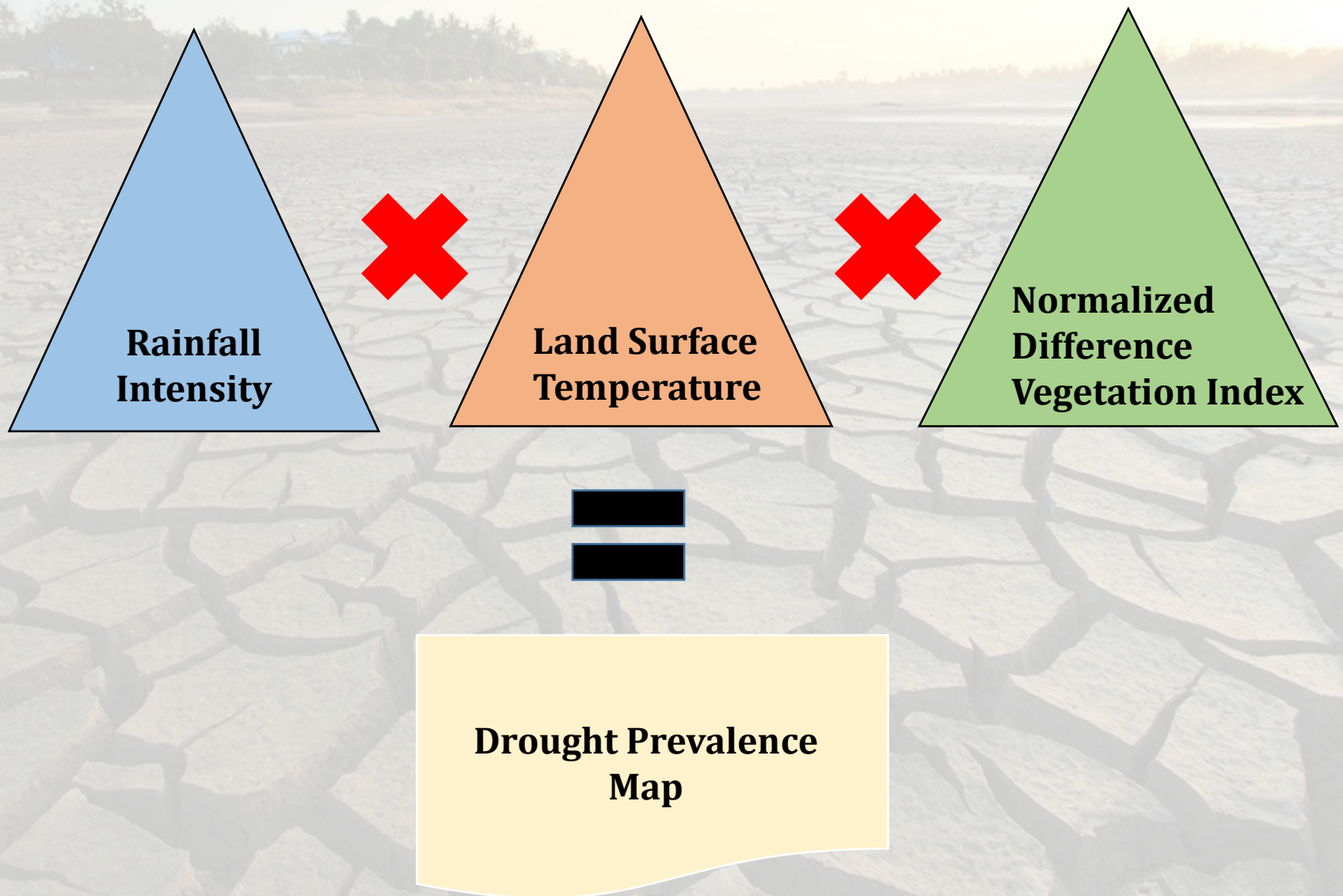- The NDVI value for Brandenburg ranges from − 1.02 to 0.67
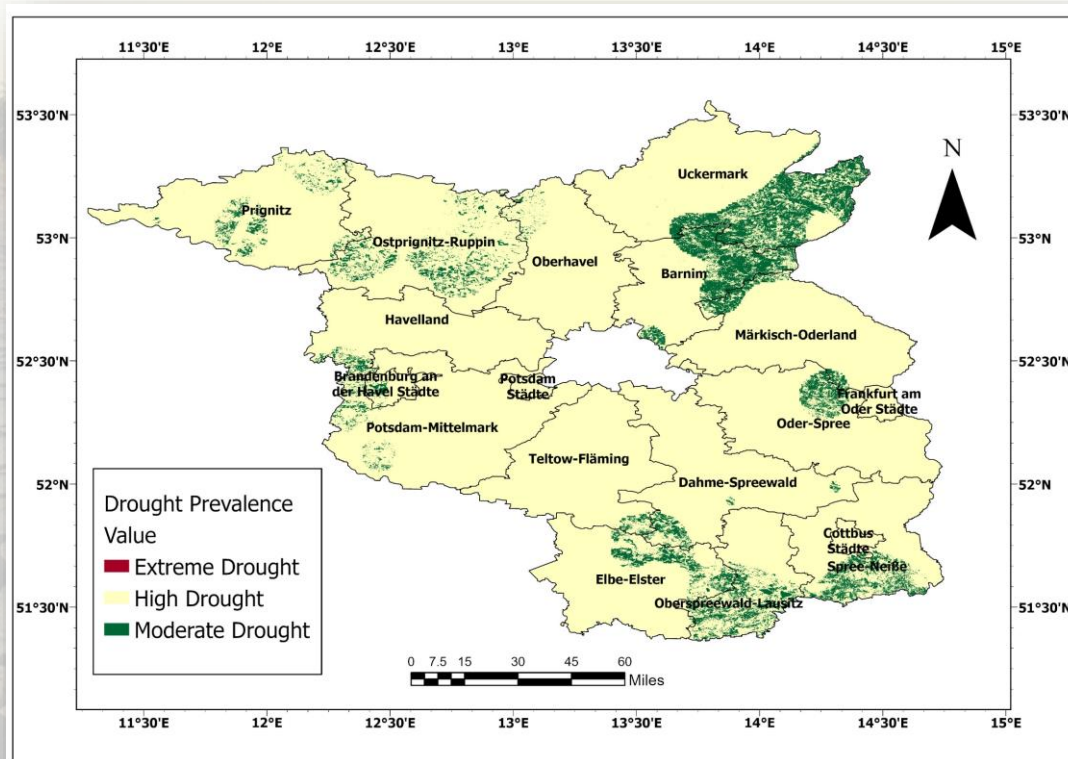

Band Calculation

$$\frac{\text{Near Infrared } - \text{ Red}}{\text{Near Infrared } + \text{ Red}}$$

Weighting Process

Rainfall Intensity × Land Surface Temperature × Normalized Difference Vegetation Index = Drought Prevalence Map

Drought prevalence in Brandenburg in 2018

Drought Prevalence Map (2018)

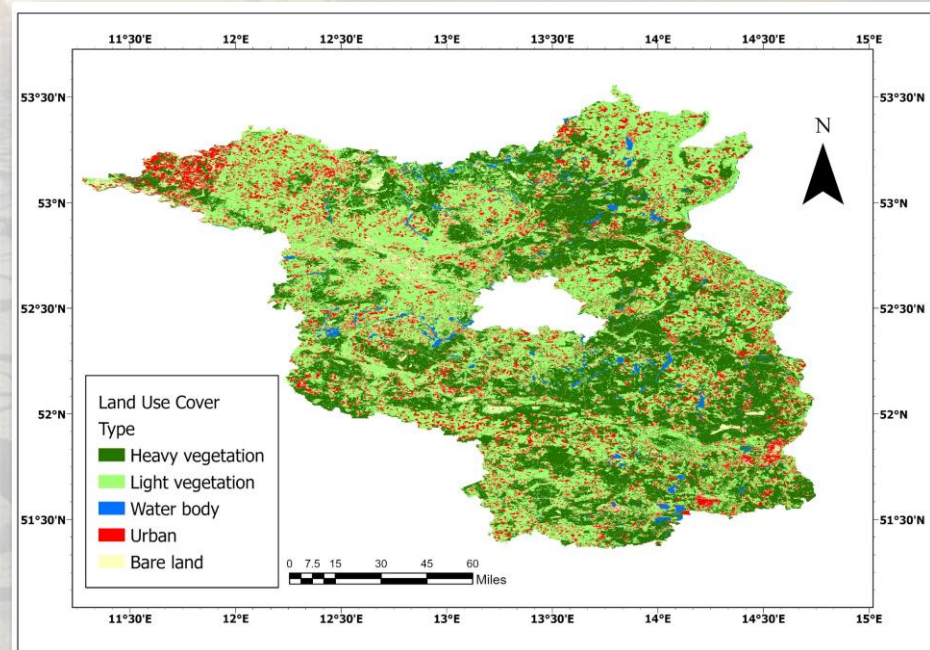| Drought Prevalence	Area (SqKm)	Percentage
Extreme Drought	0.19	1
High Drought	27,093.05	91
Moderate Drought	2384	8
Total	**29,478**	100%

Land Use and Land Cover

- **Landsat 8** Satellite Imagery was used.

- Interactive **Supervised Classification.**

  - Agricultural Area
    - ❏ **Heavy Vegetation**
    - ❏ **Light Vegetation**

  - Non Agricultural Area
   - ❏ **Waterbody**
    - ❏ **Urban**
    - ❏ **Bareland**

Reclassified LULC	Area (SqKm)	Percentage
Agricultural area (vegetation)	**21.60837**	**73%**
Non-agricultural area	7869.63	27%
Total	**29,478**	100%

Drought and Agriculture

The **extent of agricultural lands** (including forests) impacted by the **2018 drought** in the region (as the region is predominantly agrarian) was examined.

Agricultural Area affected by Drought
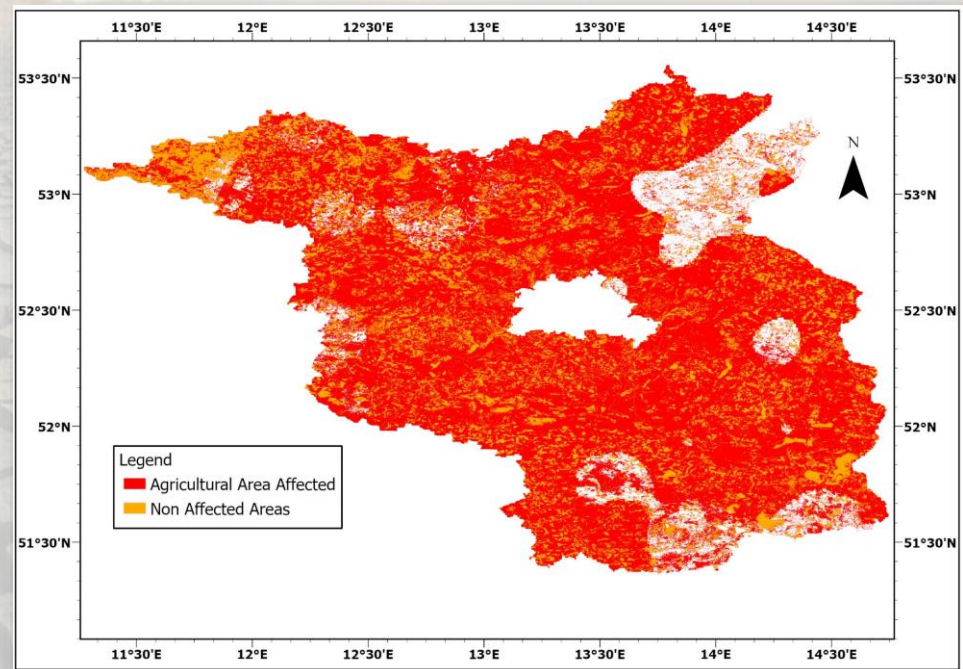
Total Agricultural lands (Sqkm)	21,608.37
Agricultural lands impacted by high drought (SqKm)	16,756.06
Percentage	77%
Total	29,478

Recommendation

❑ As highlighted in the relationship between drought and agricultural land use in our analysis.

❑ Drought relief funds should be disbursed using **Drought impact maps** for a better representation of those (farmers) severely affected by the 2018 drought.

❑ Proactive **Drought early warning system** using **Earth Observation dataset** should be encouraged. This would ensure people get *prepared and take preventing measures before drought strikes.*

❑ *We strongly recommend that '**PLAN' model** is adopted in future drought studies while integrating a multi-criteria approach.*

'The next pandemic': drought is a hidden global crisis, UN says

Countries urged to take urgent action on managing water and land and tackling the climate emergency

UNDRR
UN Office for Disaster Risk Reduction

Over **half of the world's population** will live in water-stressed regions by 2050

THANK YOU!