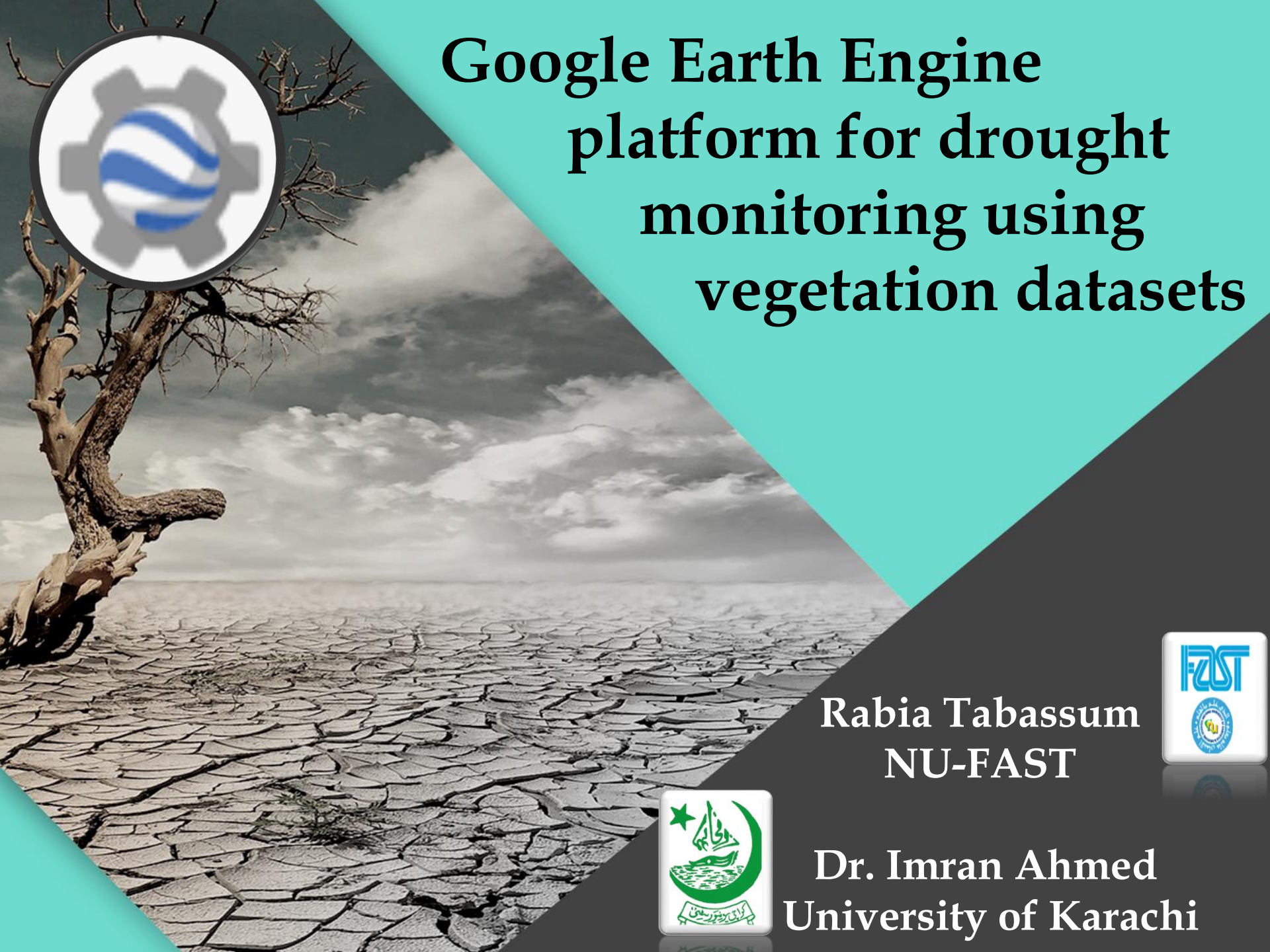




Google Earth Engine platform for drought monitoring using vegetation datasets



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NU-FAST



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Presentation Outline

Introduction

Study Area

Methodology

Findings

Conclusions

Recommendations



Introduction

- * Drought
- * Drought in Pakistan
- * Google Earth Engine



Drought



Drought is a major natural disaster that is more influenced due to climate change. The impacts of drought conditions on precipitation, soil, agricultural fields and water reservoirs are analyzed to categorize drought as



Hydrological Drought

When low water supply becomes evident in the water system.



Meteorological Drought

When dry weather patterns dominate an area.



Agricultural Drought

When crops become affected by drought.



Socioeconomic Drought

When the supply and demand of various commodities is affected by drought.



Ecological Drought

When natural ecosystems are affected by drought.



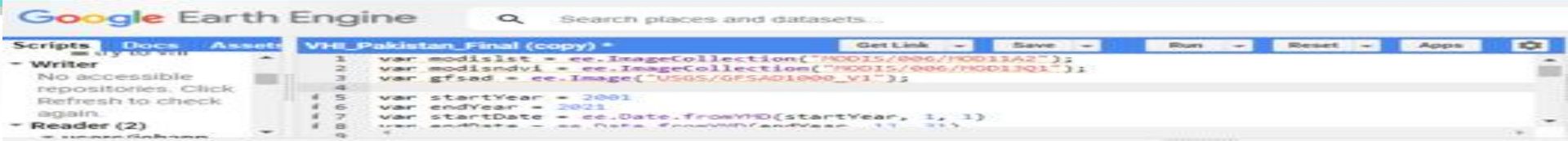
Drought in Pakistan



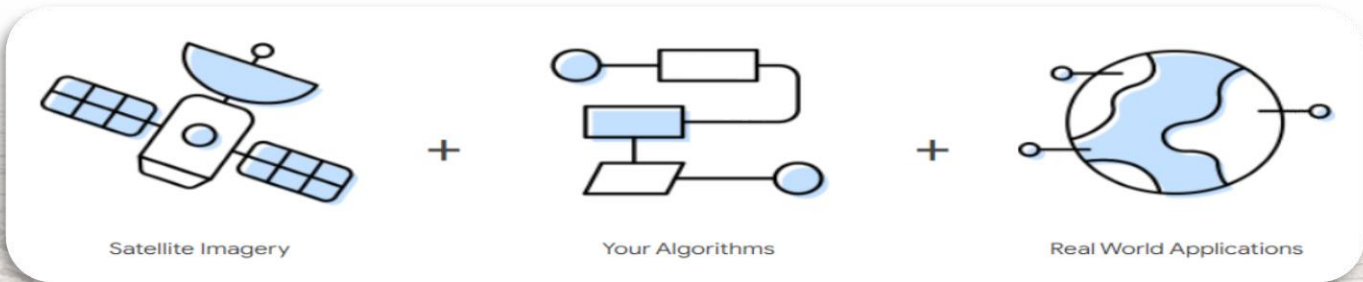
- Droughts in the Pakistan region are mainly due to failures of rains from the southwest monsoon with some association between El Nino and La Nina events and weak monsoons.
- According to a publisher, German watch, of the Climate Change Performance Index (CCPI) Pakistan is the seventh most prone country in terms of climate change .
- Javid et al. (2019) indicated that major area of the Sindh and Baluchistan provinces, and southern Punjab are possible drought prone regions.



Google Earth Engine



- Google Earth Engine (GEE), cloud-based web, is a combination of a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities.
- The major significance of GEE is time saving and quick processing.
- Scientists, researchers, and developers use Earth Engine to discover changes, map trends, and quantify differences on the Earth's surface.





Google Earth Engine



Google Earth Engine

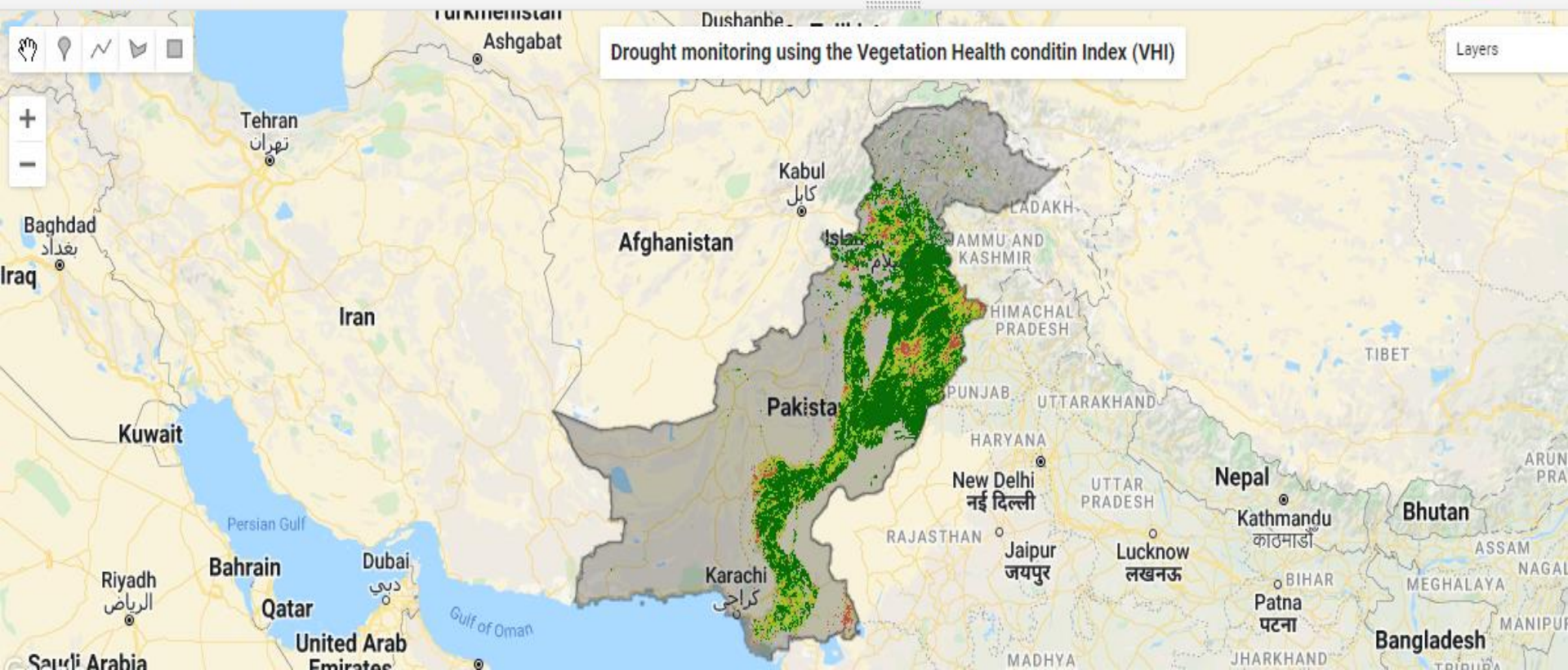
Search places and datasets...

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2 var modisndvi = ee.ImageCollection("MODIS/006/MOD13Q1");  
3 var gfsad = ee.Image("USGS/GFSAD1000_V1");  
4  
5 var startYear = 2001  
6 var endYear = 2021  
7 var startDate = ee.Date.fromYMD(startYear, 1, 1)  
8 var endDate = ee.Date.fromYMD(endYear, 12, 31)  
9
```

Inspector Console Tasks

● Extreme Drought ● Severe Drought

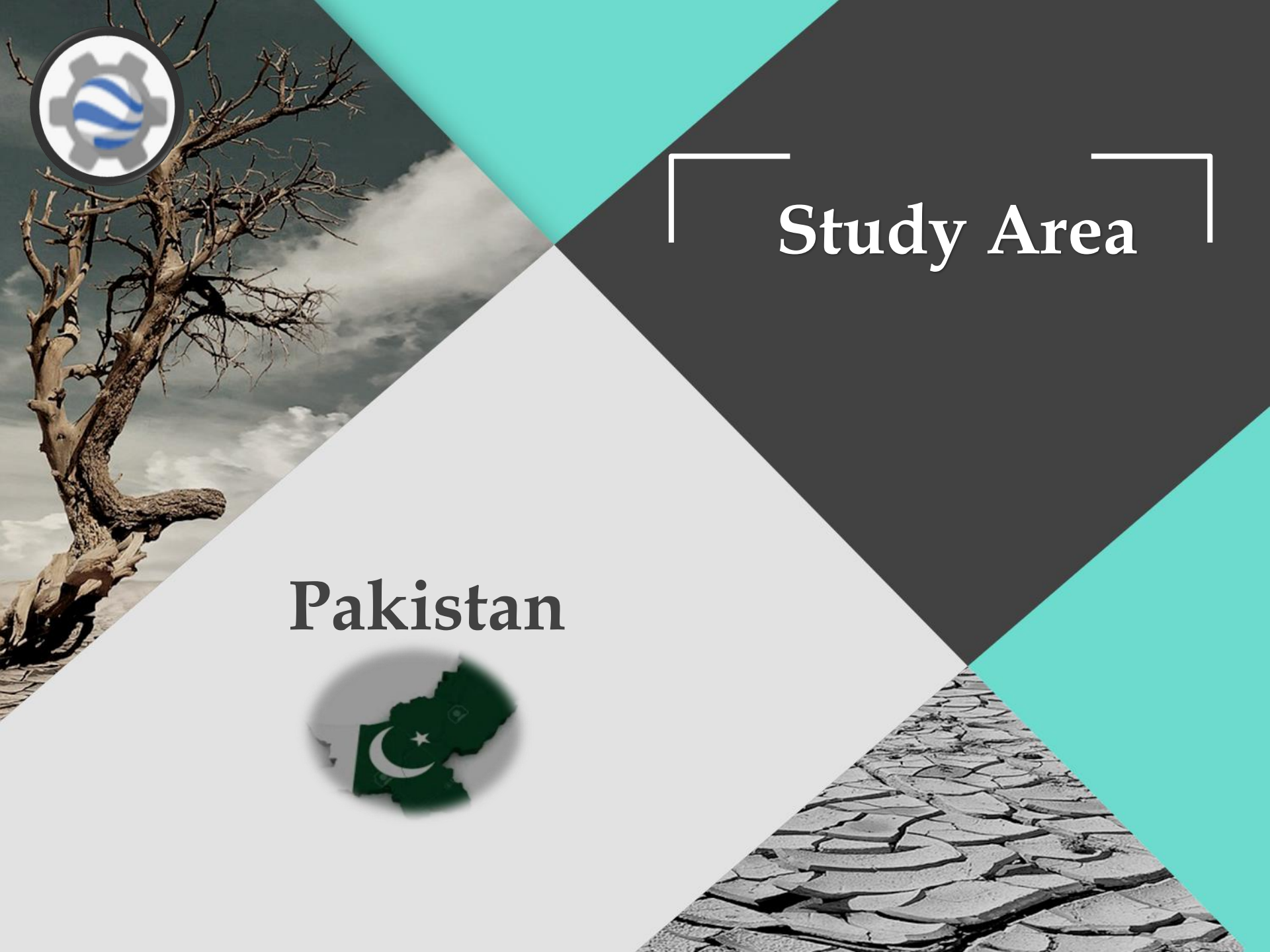
59.4%





Study Area

Pakistan





Pakistan



Pakistan (latitudes 23°30 'N-37°30 'N and longitudes 61°E-78°E), located in South Asia covers an area of 796,095 km².

It experiences four seasons defined based on temperature;

- Cool and dry winter (Dec-Feb)
- Hot and dry spring (Mar-May)
- Hot and humid summer (Jun-Aug)
- Dry autumn (Sep-Nov)

It experiences two monsoon precipitation seasons;

- The Indian monsoon (July-Sep)
- The western disturbance (Dec-Mar).

Pakistan having a population of approximately 160 million



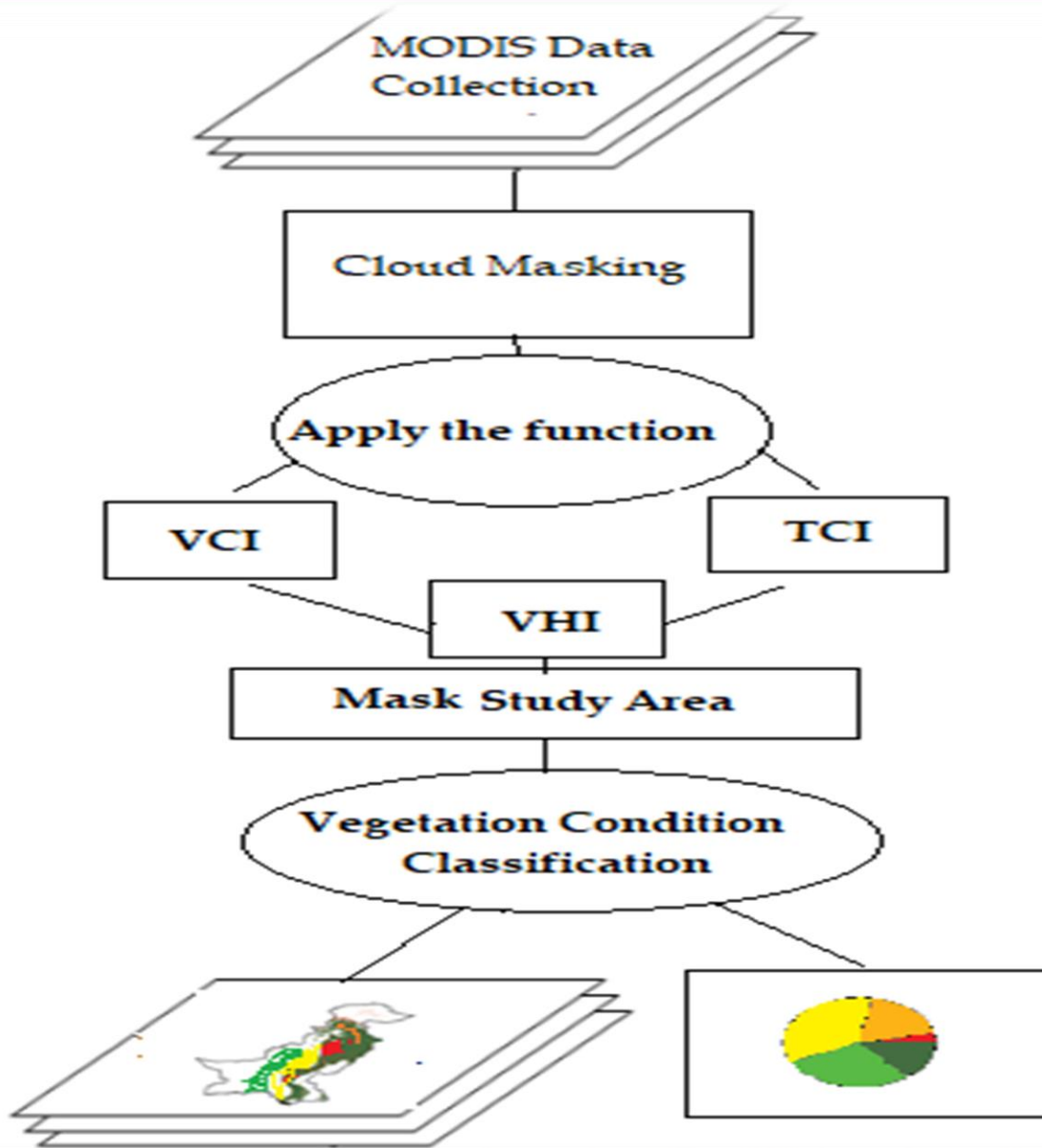


Methodology





Methodology





Data



- Moderate Resolution Imaging Spectroradiometer (MODIS) data set
 - Terra MODIS 8-day composite MOD11A2 LST 1 km spatial resolution satellite images
 - 16-day composite MOD13A2 1 km spatial resolution vegetation index images
- High-resolution global cropland data
- Pakistan Shape file



Vegetation Indices



- Vegetation Condition Index (VCI)

$$VCI = \frac{NDVI_i - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$$

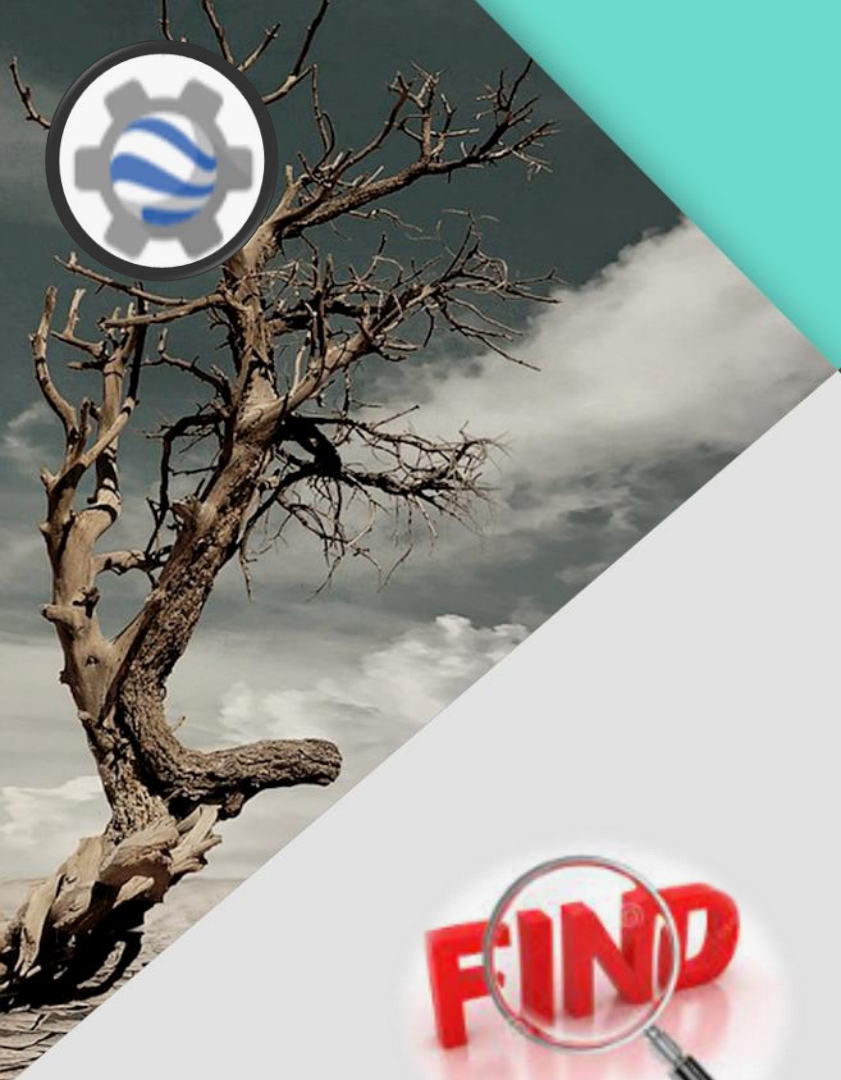
- Temperature Condition Index (TCI)

$$TCI = \frac{LST_{max} - LST_i}{LST_{max} - LST_{min}}$$

- Vegetation Health Index (VHI)

$$VHI = \alpha * VCI + (1 - \alpha) * TCI$$

where α is 0.5

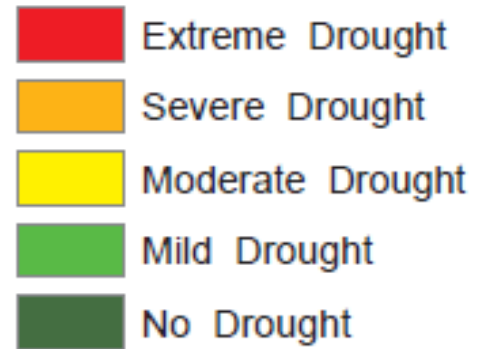
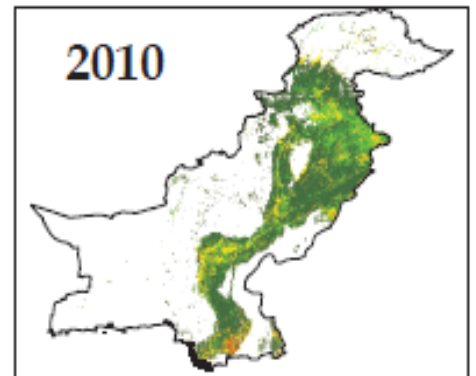
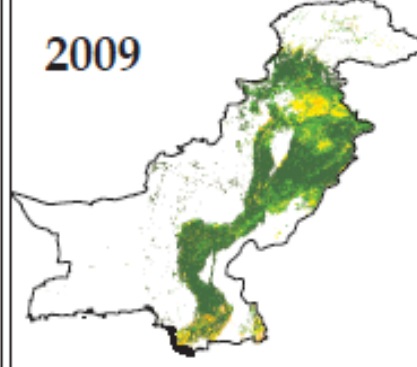
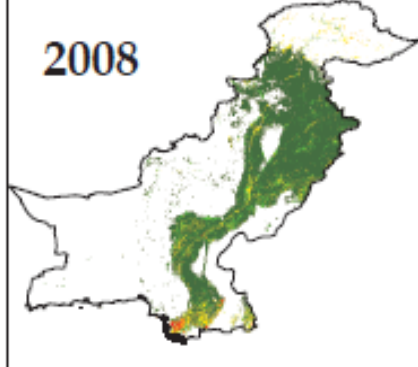
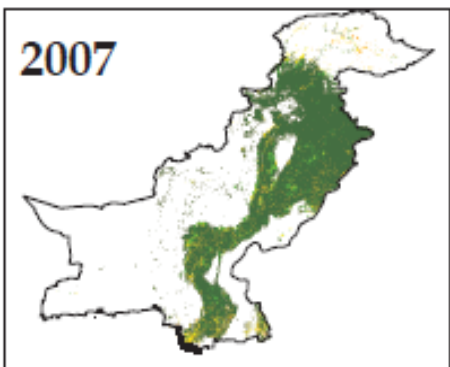
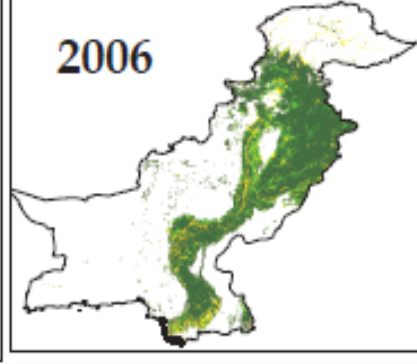
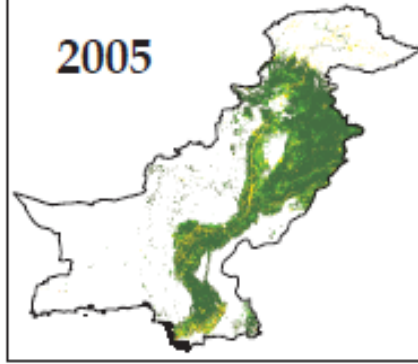
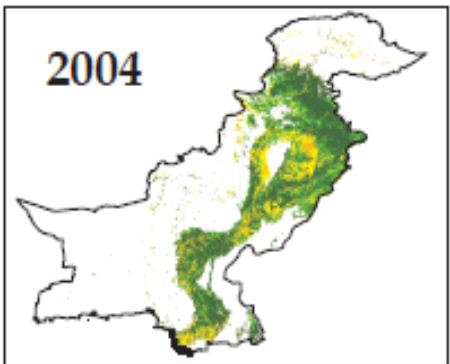
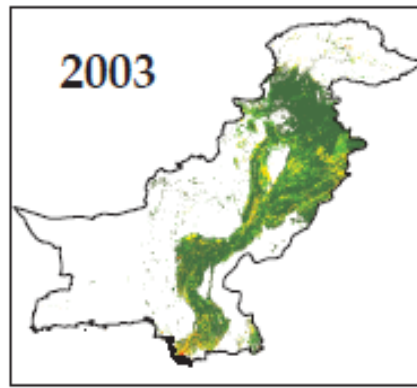
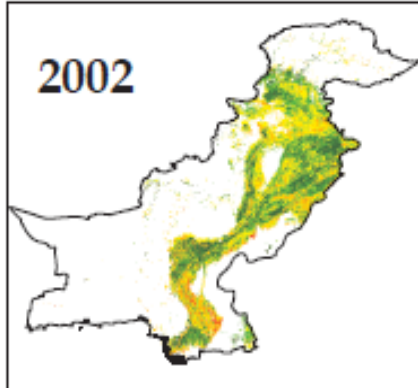
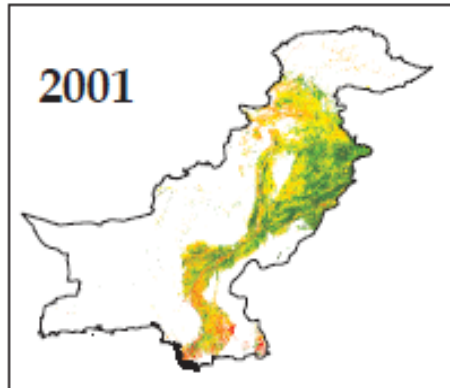


Findings



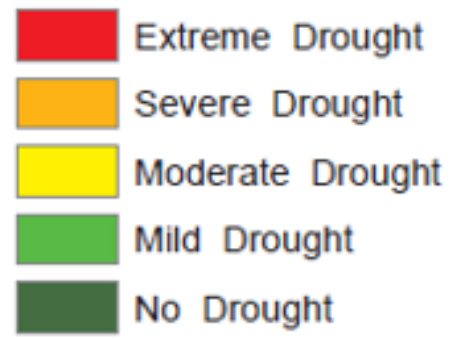
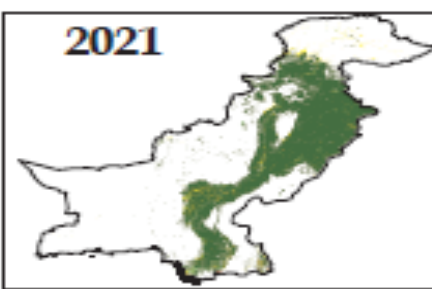
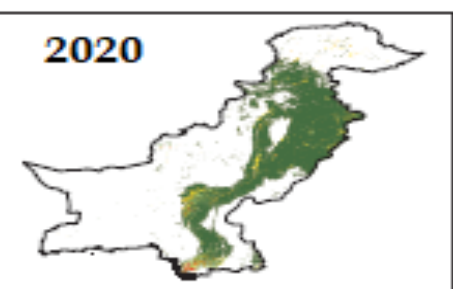
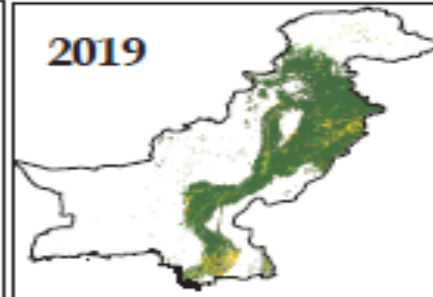
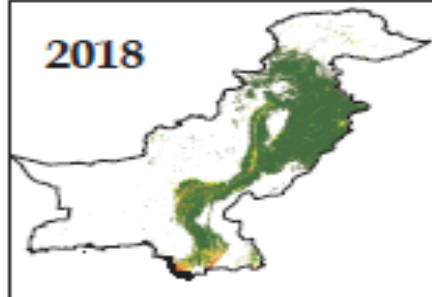
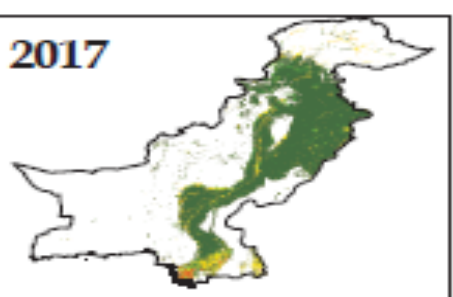
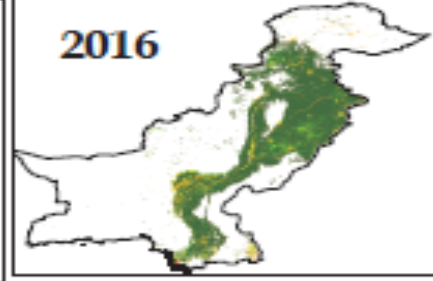
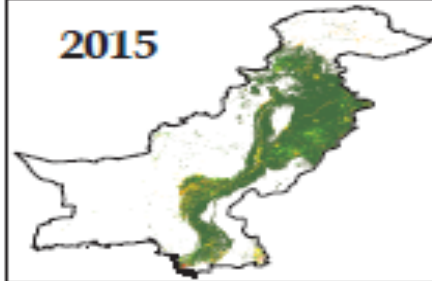
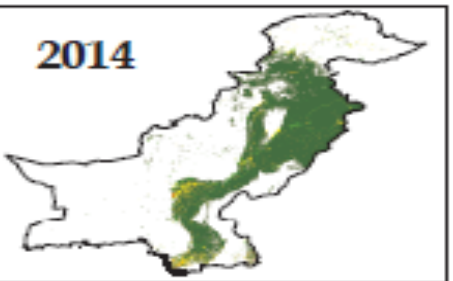
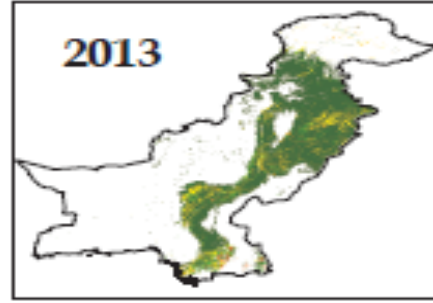
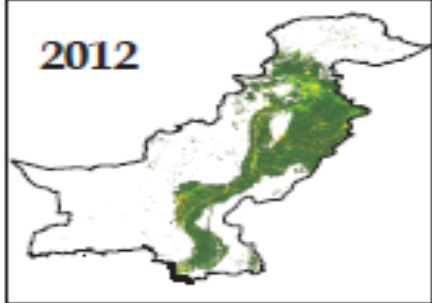
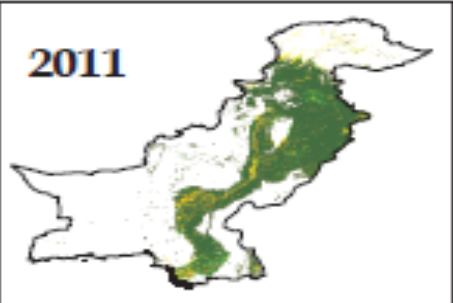


Vegetation Health Index 2001 to 2010





Vegetation Health Index 2011 to 2021

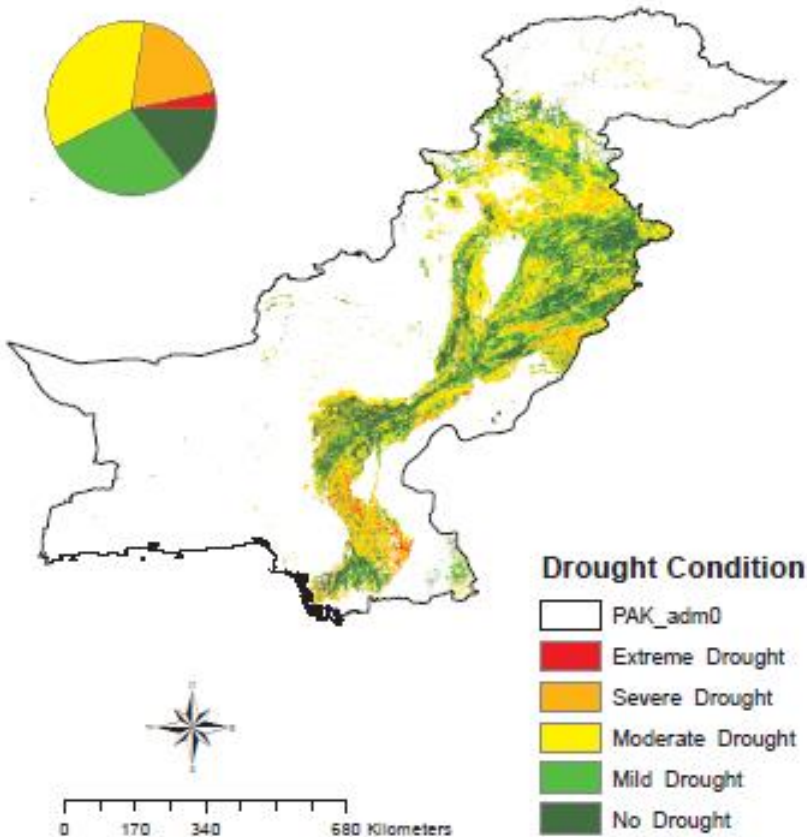




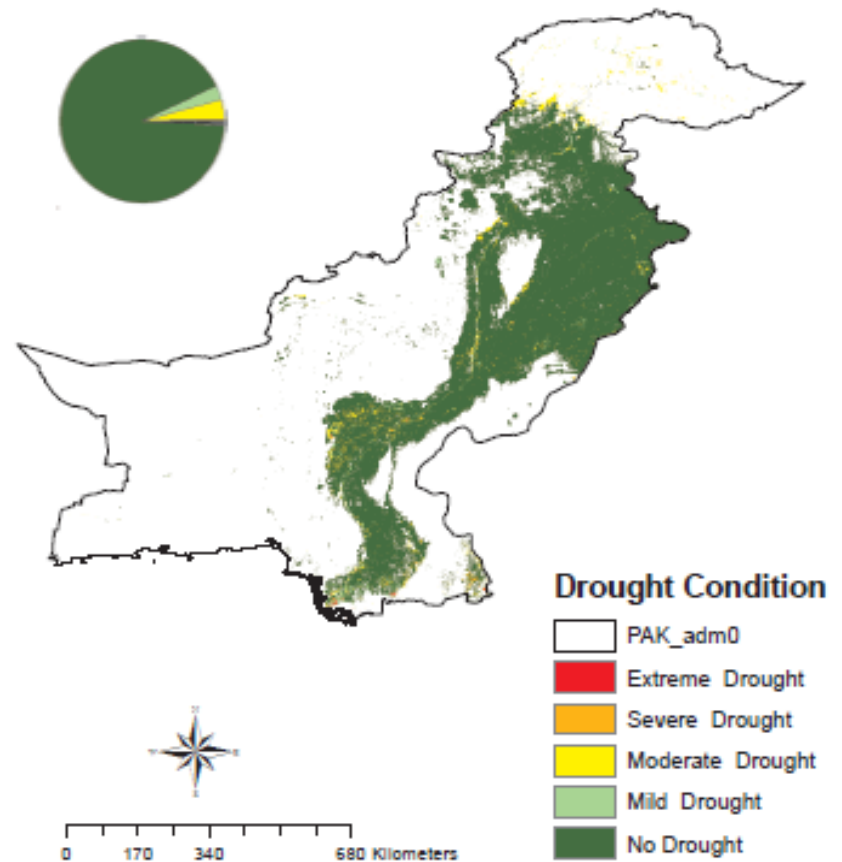
Vegetation Health Index



VHI 2001



VHI 2020

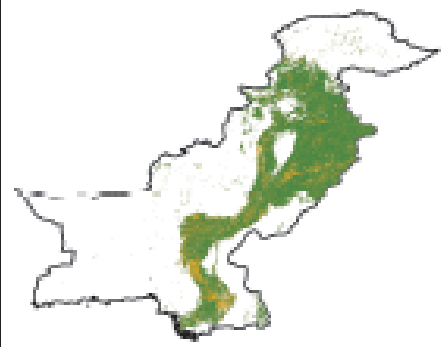




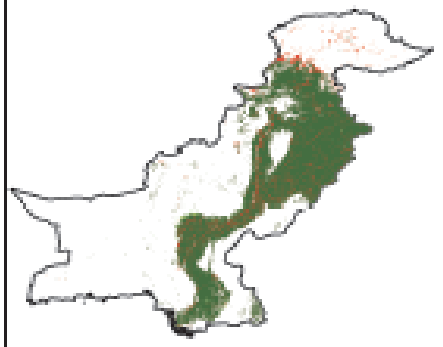
Monthly Mean VHI during 2000-2021



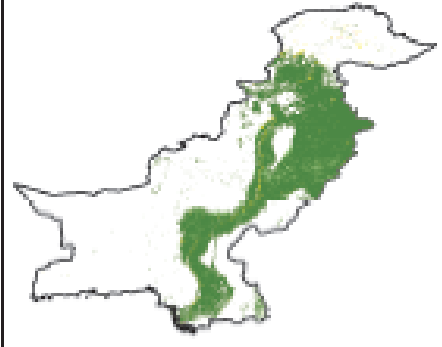
January









February



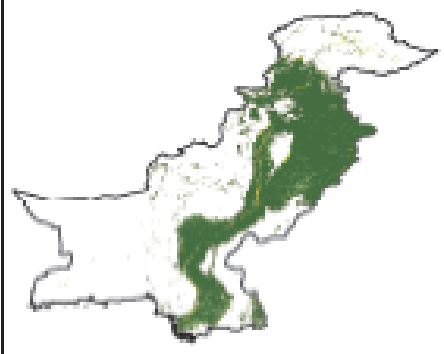
March



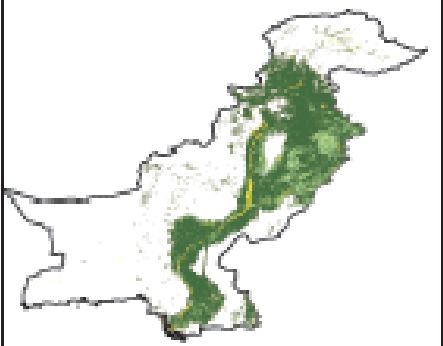
Drought Conditions

-  Extreme Drought
-  Severe Drought
-  Moderate Drought
-  Mild Drought
-  No Drought
-  Pakistan Boundary

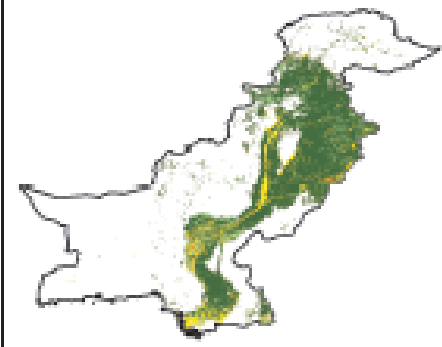
April



May



June

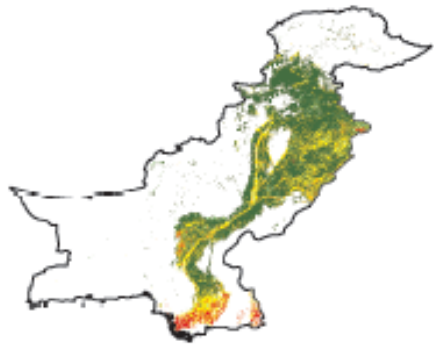




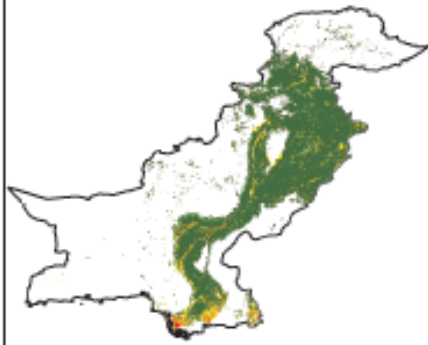
Monthly Mean VHI during 2000-2021



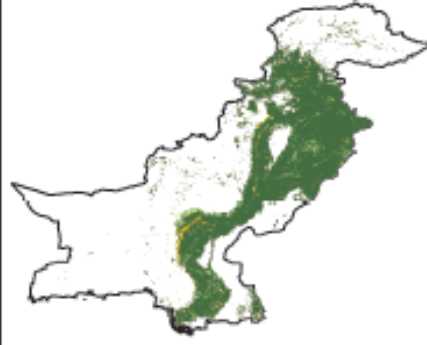
July



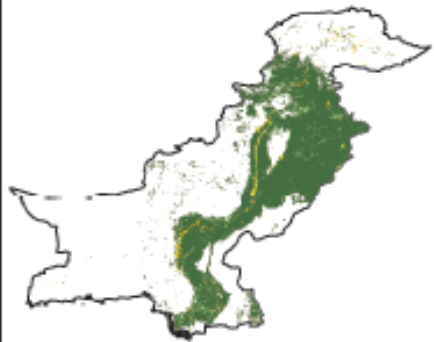
August



September



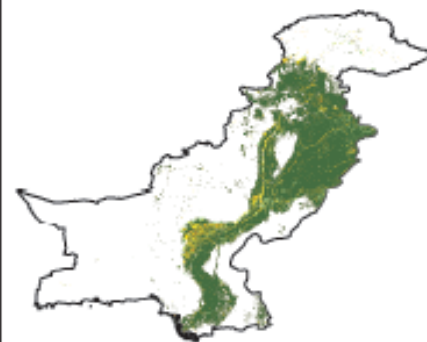
October









November



December



Drought Conditions

-  Extreme Drought
-  Severe Drought
-  Moderate Drought
-  Mild Drought
-  No Drought
-  Pakistan Boundary

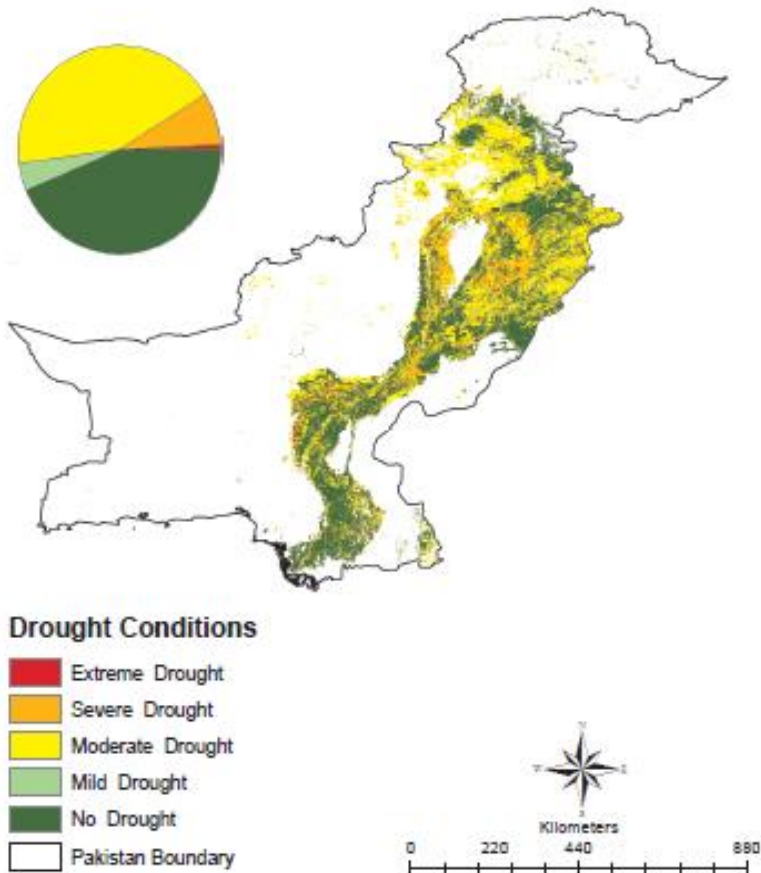




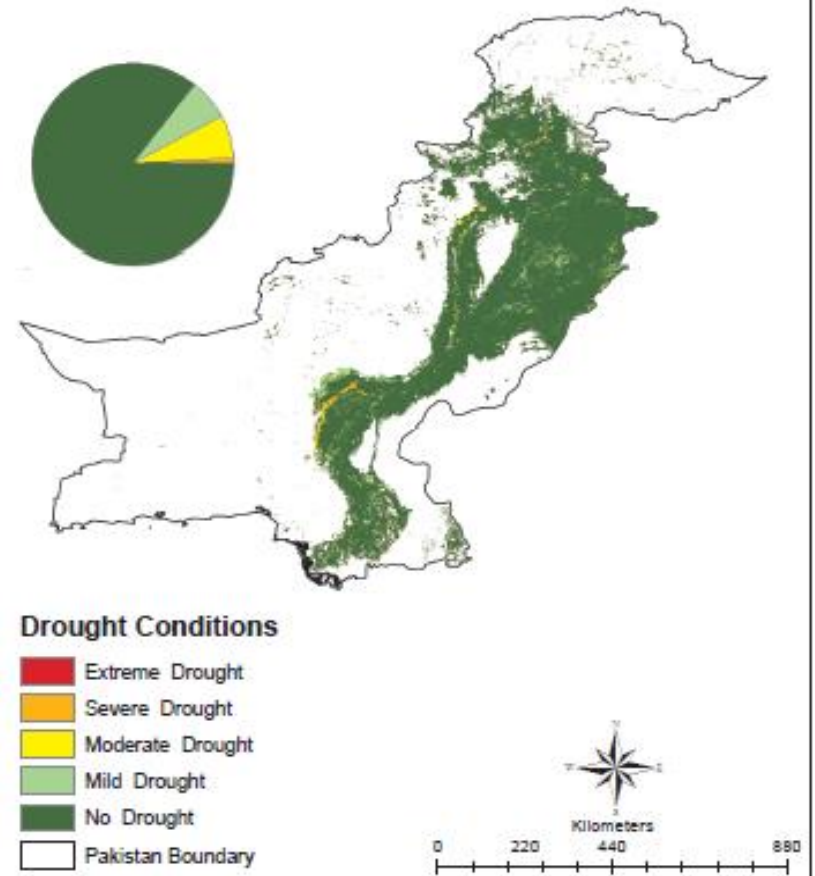
Vegetation Health Index



Mean VHI for November (2001 to 2021)



Mean VHI for September (2001 to 2021)





Vegetation Health Index

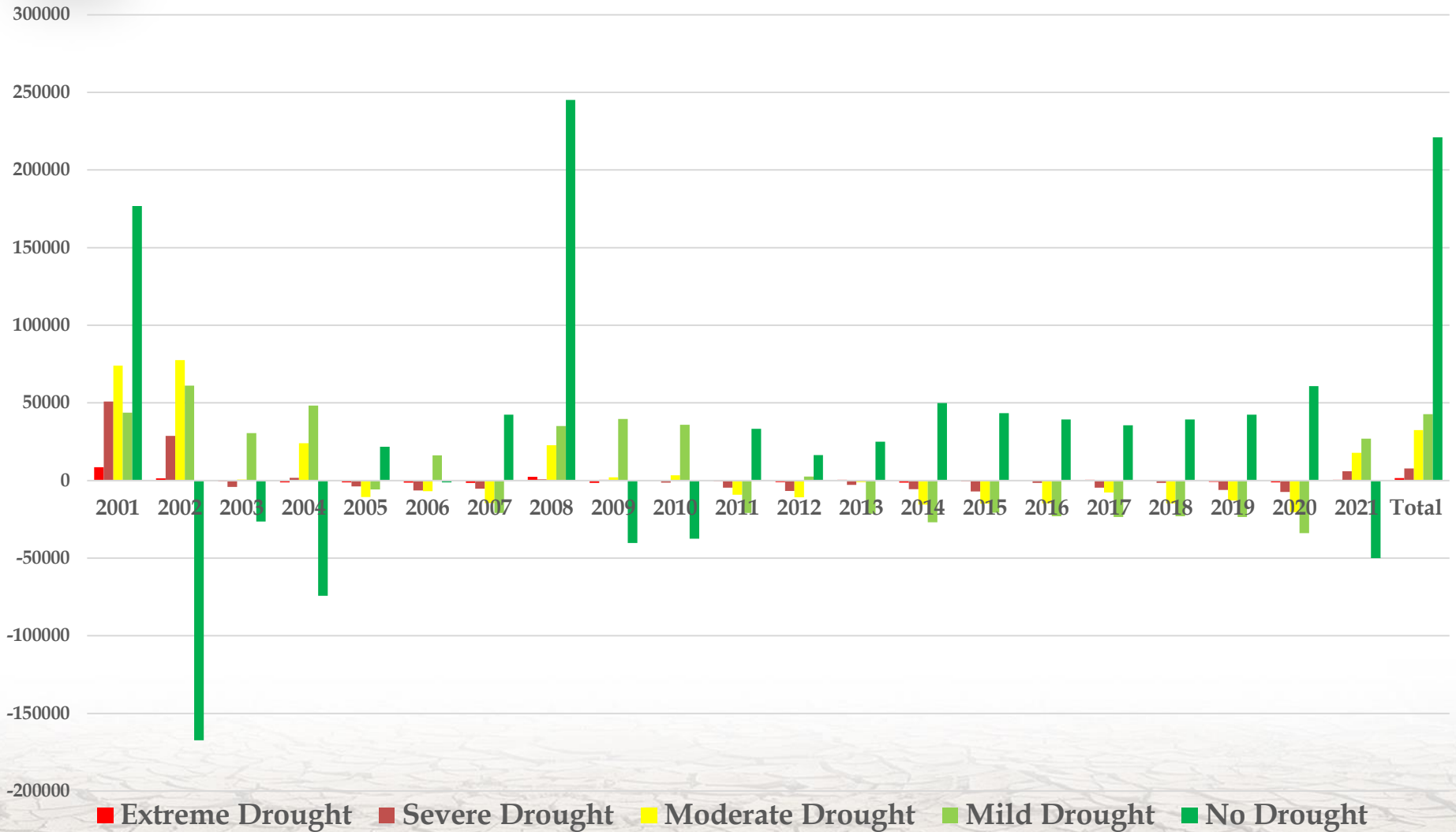


Drought condition using VHI during 2001 to 2021





Vegetation Health Index Anomaly

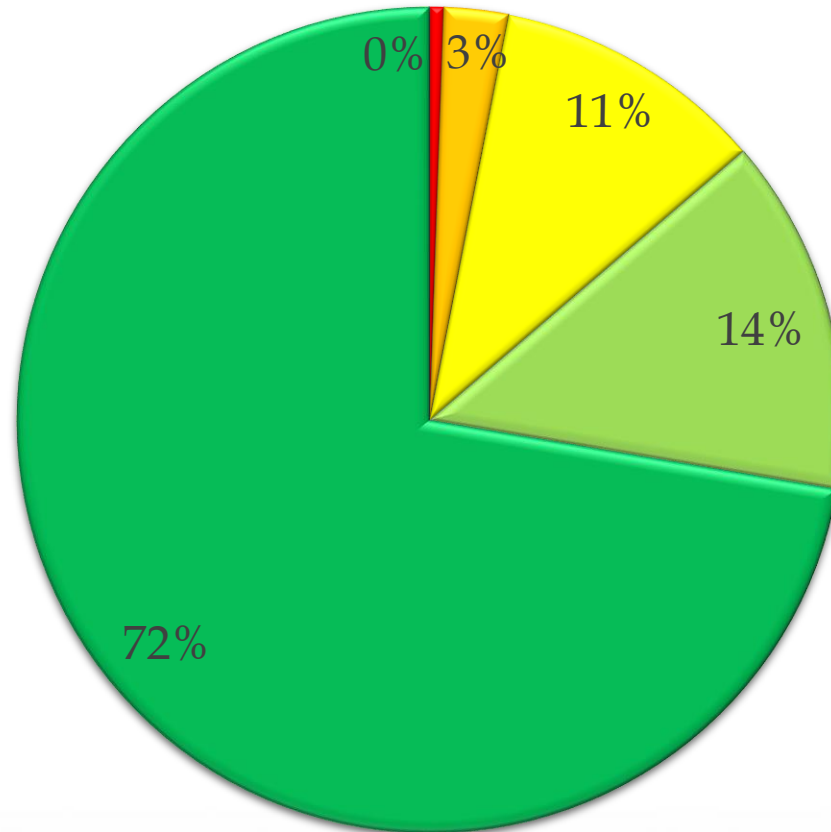




Vegetation Health Index



Average Drought Condition during 2001 to 2021



- Extreme Drought
- Severe Drought
- Moderate Drought
- Mild Drought
- No Drought



Conclusion And Recommendations





Conclusions



- GEE is a cloud-based web that can quickly process large data and save time.
- Yearly based drought index show that in 2001 and 2002, the most of the crop land were effected due to severe and moderate drought. In 2004 and 2009, some of the area were observed moderate drought.
- Monthly 20 years data observations indicated that the major areas of Pakistan were effected due to moderate drought in November.
- In July, some region of Sindh were effected with extreme and severe drought .



Recommendations



- Drought is one of the extreme hazards in Pakistan and its early prediction help to establish best mitigation plan.
- This study limited to use only VCI, TCI, and VHI for drought monitoring. It is recommended that other drought indices such as SVI, NDDI, and NMDI can also provide drought assessment.
- The comparison of these indices helps to select the most effective drought index.
- For drought prediction in future, time series of these indices can be used.

