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Evaluating & comparing NDVI & NBR indices performance for burned areas in terms of PBIA and OBIA in Aegean Region, Turkey

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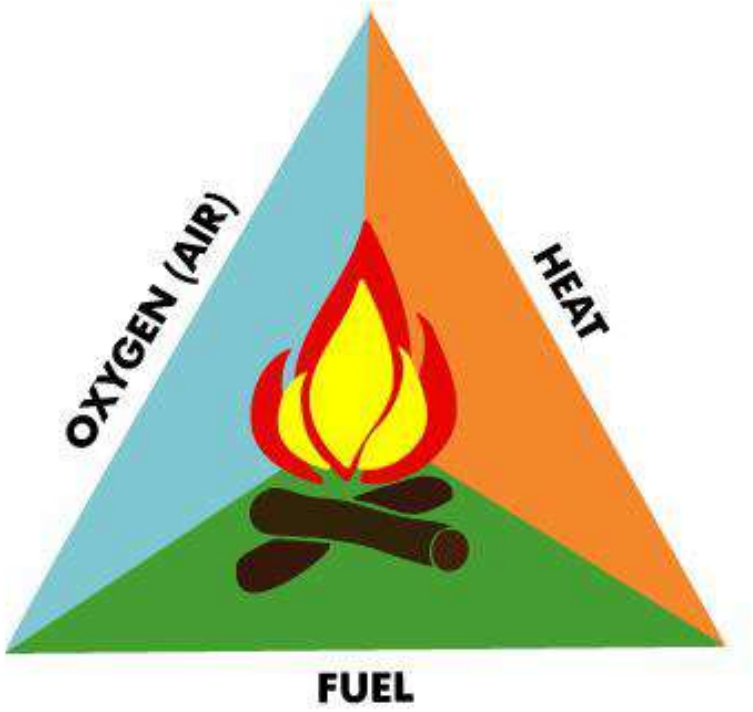
Outline

- What is forest fires?
- Where do forest fires take place? / When do forest fires happen?
- How do forest fires spread so quickly? / How can you control a fire?
- Types of forest fires
- Causes of forest fires/ Effects of forest fires
- Forest fires statistics in Turkey
- Remote sensing importance
- Study area
- Methods
- NBR
- NDVI
- Pixel based image analysis
- Object based image analysis
- Results

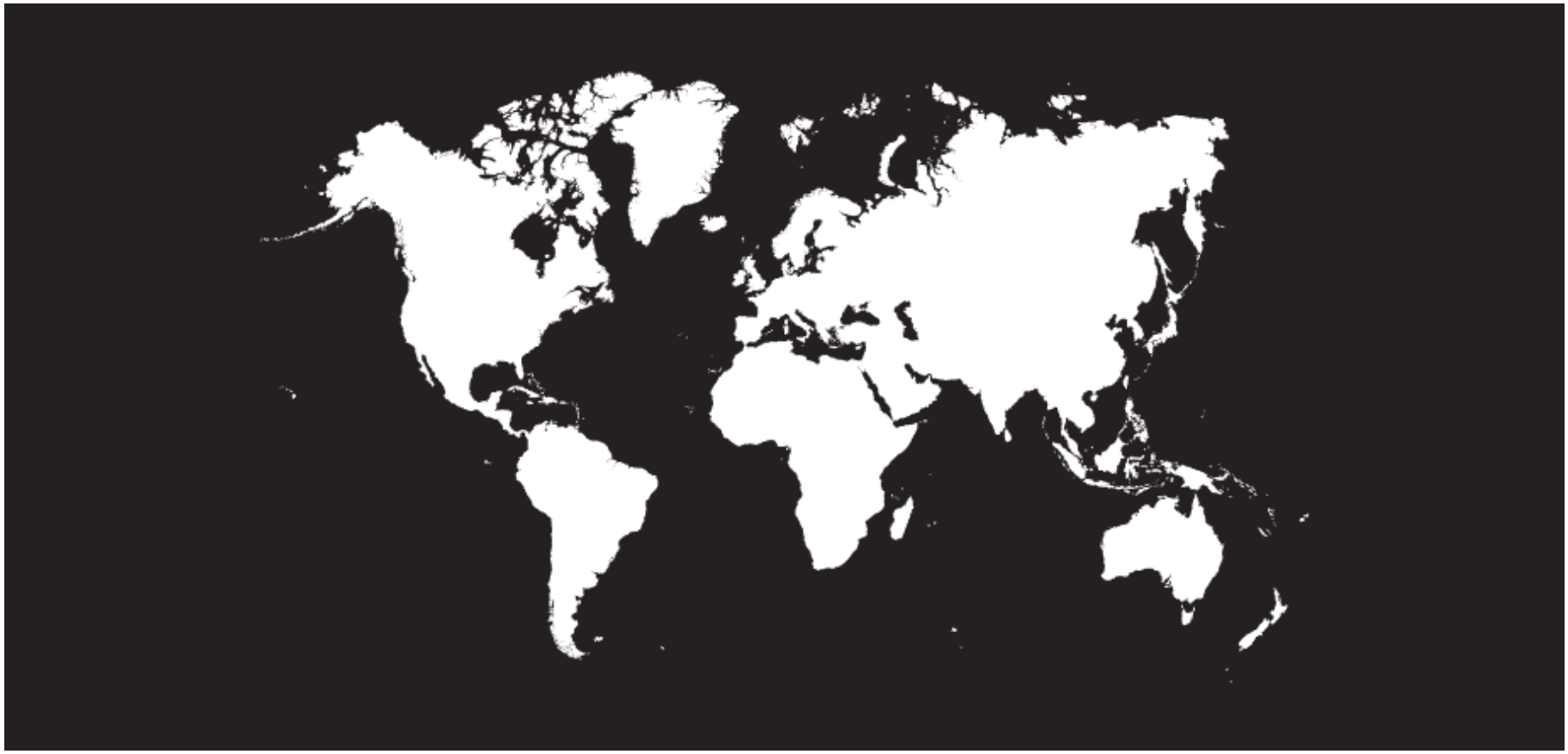
Natural Hazards /Wildfires



- A forest fire is a natural disaster consisting of a fire which destroys a forested area, and can be a great danger to people who live in forests as well as wildlife. Forest fires are generally started by lightning, but also by human negligence or arson, and can burn thousands of square kilometers.
- A wildfire or wildland fire is a fire in an area of combustible vegetation that occurs in the countryside or rural area.

Wildfires are one of the most destructive natural hazards not only affects the ecosystem adversely but also causes serious problem in economic and social life.

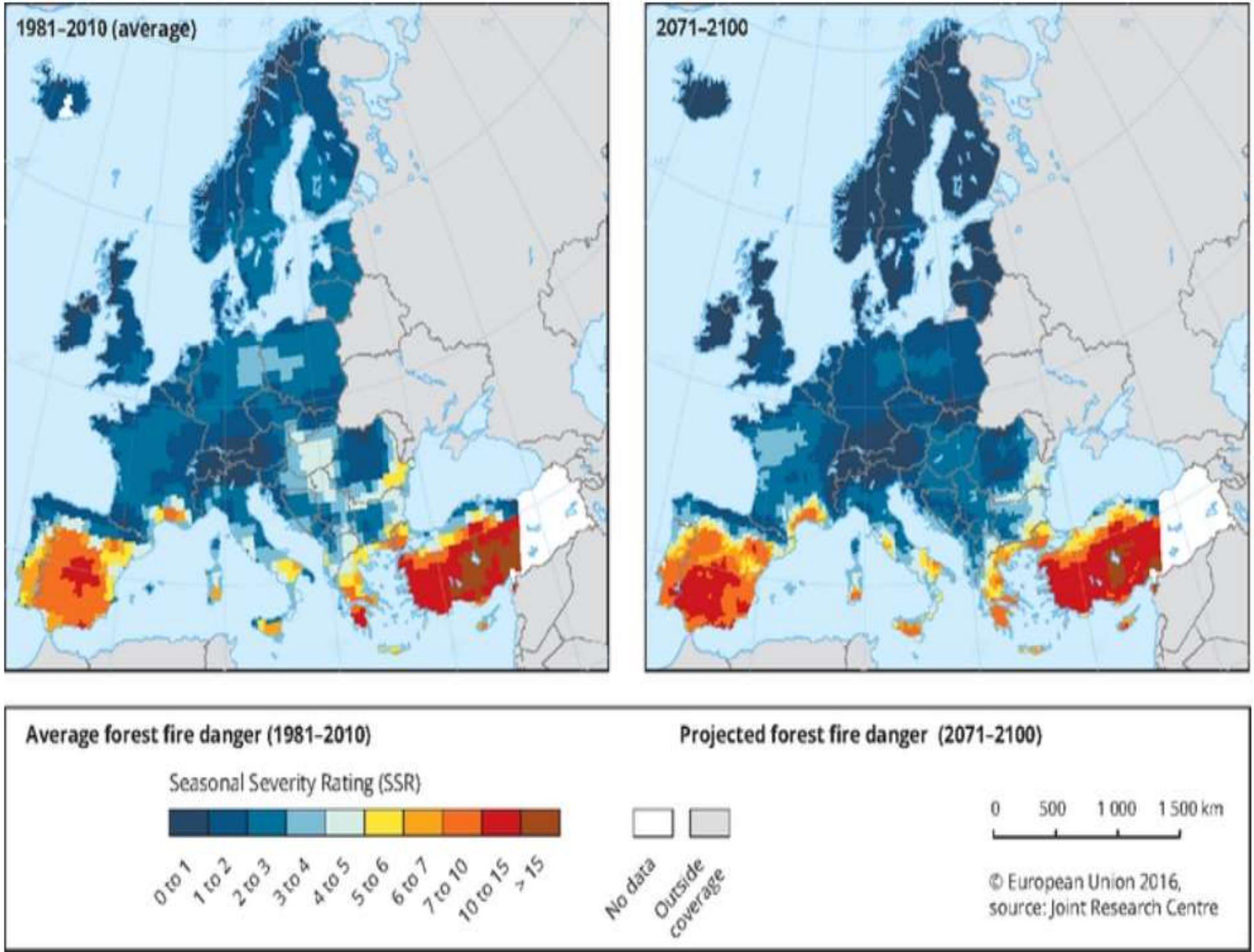
Where do wild fires take place?



Wild fires take place all over the world.
Major fires happen every years in the forests of the United States, Australia and Mediterranean.

When do forest fires happen?

- Forest fires happen mainly in the summer and autumn.
- They are particularly destructive when there is a drought because branches and twigs die and dry out, creating plenty of fuel for the fire.
- Aegean and Mediterranean regions have been facing forest fires frequently due to continental climate conditions with hot and dry summers.


1981–2010 (average)
2071–2100
Average forest fire danger (1981–2010)
Projected forest fire danger (2071–2100)
Seasonal Severity Rating (SSR)
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 6
6 to 7
7 to 10
10 to 15
> 15
No data
Outside coverage
0 500 1 000 1 500 km
© European Union 2016,
source: Joint Research Centre

How do forest fires spread so quickly?

- Wind is a major factor. Some fires spread along the dead leaves and branches at the bottom of trees.
- Also, burning leaves and branches can get blown ahead of the main fire causing smaller fires to start.

How can you control a fire?

- Planes and helicopters drop water and chemical fire retardant.
- Fire-fighters create a control line – an area where they remove all the fuel so that the fire can't travel across it.
- This can be a barrier like a river or road. They then cut down dead trees to stop them falling across the fire line.
- Drip torches are used to burn the plants between the control line and the fire to remove the fuel.

Types of forest fires

Ground

Burn below the surface of the ground in the soil and sometimes in peat.

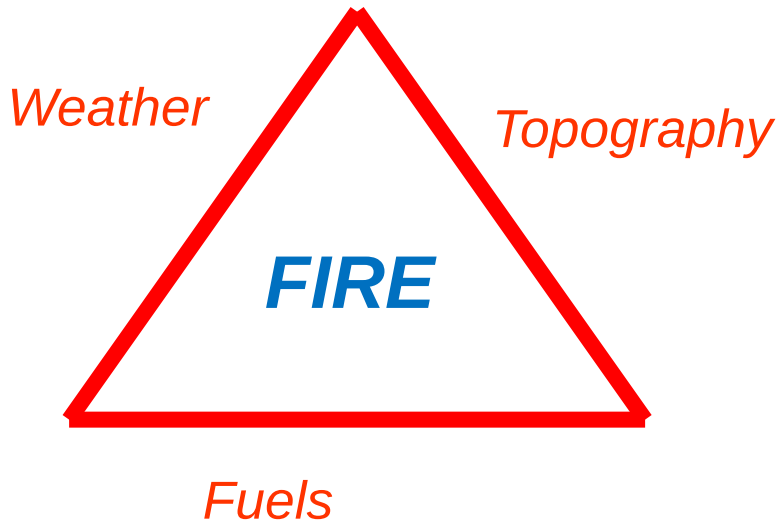
Surface

A forest fire may burn primarily as a surface fire, spreading along the ground as the surface litter on the forest floor.

Crown

Fires in the tops of the trees. Crown fires spread rapidly and very dangerous.

Fire Behavior



Components of Weather

- Temperature
- Relative Humidity
- Atmospheric Stability
- Windspeed and Direction
- Precipitation

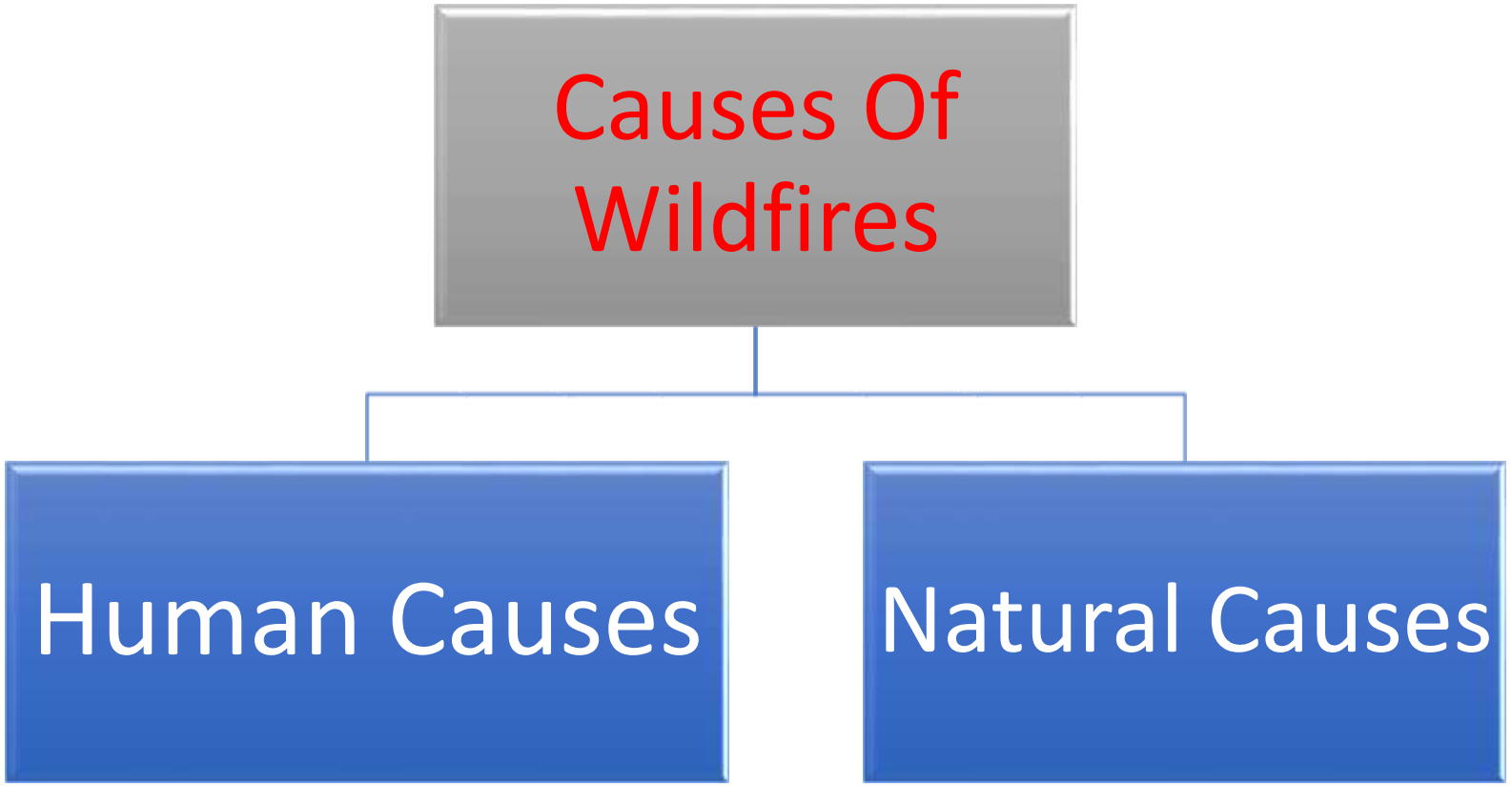
Components of the Wildland Fire Environment

Topography

- Elevation
- Position on Slope
- Aspect
- Shape of Country
- Steepness of Slope

Fuels

- Fuel Loading
- Size and Shape
- Compactness
- Horizontal Continuity
- Vertical Continuity
- Chemical Content


Causes Of Wildfires
Human Causes
Natural Causes

Human causes account for about %90 of all wildfires.

Smoking

Arson

Burning Debris

Human Causes of Fires

Car accidents

Campfires

Fireworks

Natural Causes of Fires

Lightning

Volcanic Eruption

Natural causes account for about %10 of all wildfires.

Whenever lightning strikes, sparks are produced that can initiate wildfires.

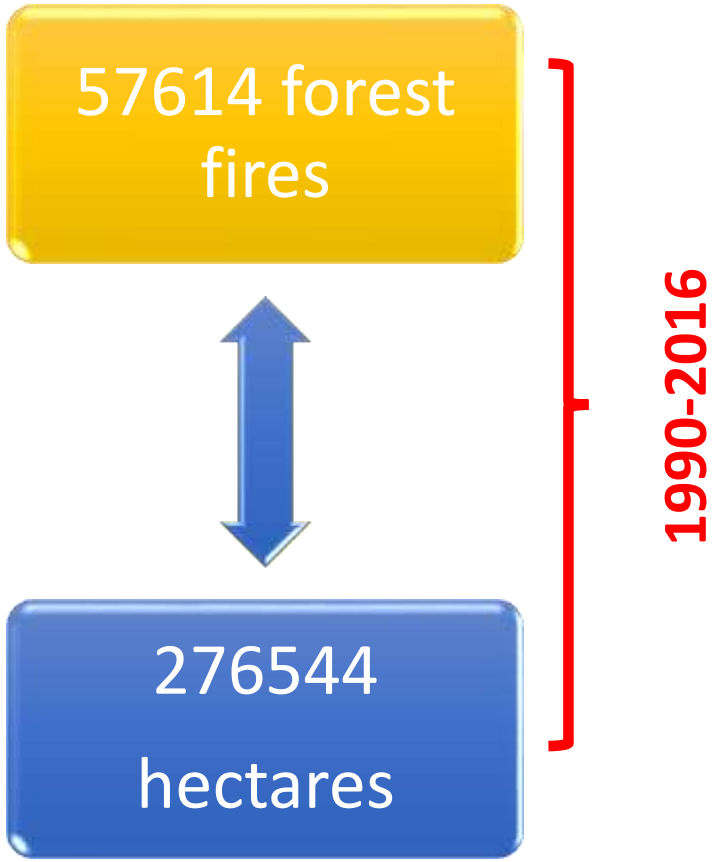
Hot magma in the earths crust is usually expelled out as lava during a volcanic eruption. The hot lava then flows into nearby fields or lands to start wildfires.

Effects of forest fire

- Loss of valuable timber resources,
- Loss of biodiversity and extinction of plants and animals,
- Loss of wildlife habitat,
- Loss of natural regeneration and reduction in forest cover,
- Global warming,
- Change in the macroclimate of the area with unhealthy living conditions
- Ozone layer depletion
- Health problems leading to diseases
- Lead to soil erossion
- Loss of livelihood for tribal people and rural area.

Forest fires statistics in Turkey

In Turkey, the coast line, which starts from Hatay and extends through the Mediterranean and Aegean up to Istanbul, has the highest fire risk. In another words, approximately 57% (12.5 million ha) of Turkey's forest area is located in fire sensitive areas.



Statistics about wildfires

- Forest fires mostly occur during the period of May-November, particularly in June, July and August.

- Between 1978 and 2010, the biggest 20 fires occurred in these regions with forest loss ranging from 1200 to 14000 ha.

Year	Fire number	Burnt Area (ha)
1990	1750	13742
1991	1481	8081
1992	2117	12232
1993	2545	15393
1994	3239	30828
1995	1770	7676
1996	1645	14922
1997	1339	6317
1998	1932	6764
1999	2075	5804
2000	2353	26353
2001	2631	7394
2002	1471	8514
2003	2177	6644
2004	1762	4876
2005	1530	2821
2006	2227	7762
2007	2135	11664
2008	2135	29746
2009	1793	4679
2010	1861	3317
2011	1954	3612
2012	2450	10455
2013	3755	11456
2014	2149	3117
2015	2150	3219
2016	3188	9156

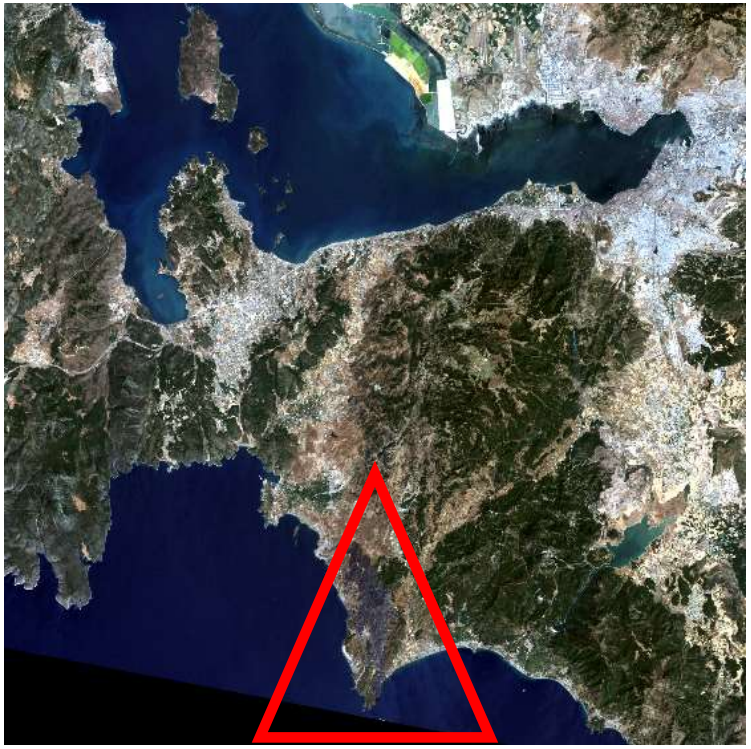
Seferihisar forest fire 10/08/2009

700 hectares forest lands burned

Study Area

Seferihisar is located between 26°45'00"E - 27°01'30"E longitudes and 38°17'00"N - 38°02'00"N latitudes. The district is bordered by Urla in the northwest and north and is neighbor to the Menderes district in the east. The surface area of Seferihisar is 380 km^2. Seferihisar is located in the Mediterranean macroclimate in terms of climate characteristics and has an average temperature of 17 º C, with an average temperature of 8 º C in January and 27 º C in July

Datasets

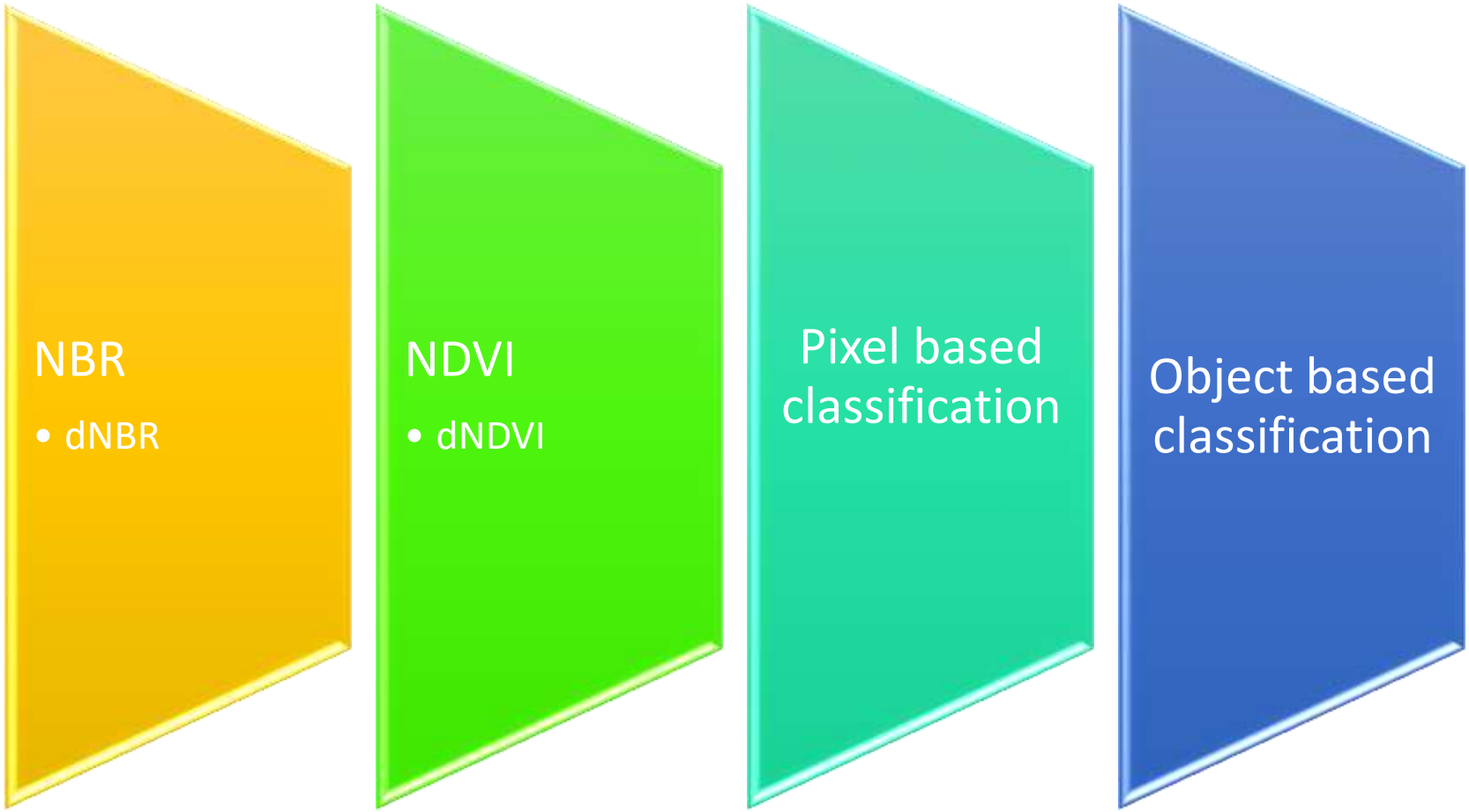


Satellites	Acquisition Date	Spatial Resolution	Sensor
Landsat 5	26/07/2009	30 m	L5
Landsat 5	14/08/2009	30 m	L5

Remote Sensing Importance

- Remote sensing technology can be used in different phases of fire management which are risk estimation, detection and assessment.
- Remotely sensed data provide rapid, accurate and reliable information for post – fire damage analysis with being spectrally sensitive to surface vegetative characteristics and structure.
- Multi temporal data acquisition and synoptic viewing capability are possible with remote sensing satellites.

Methods

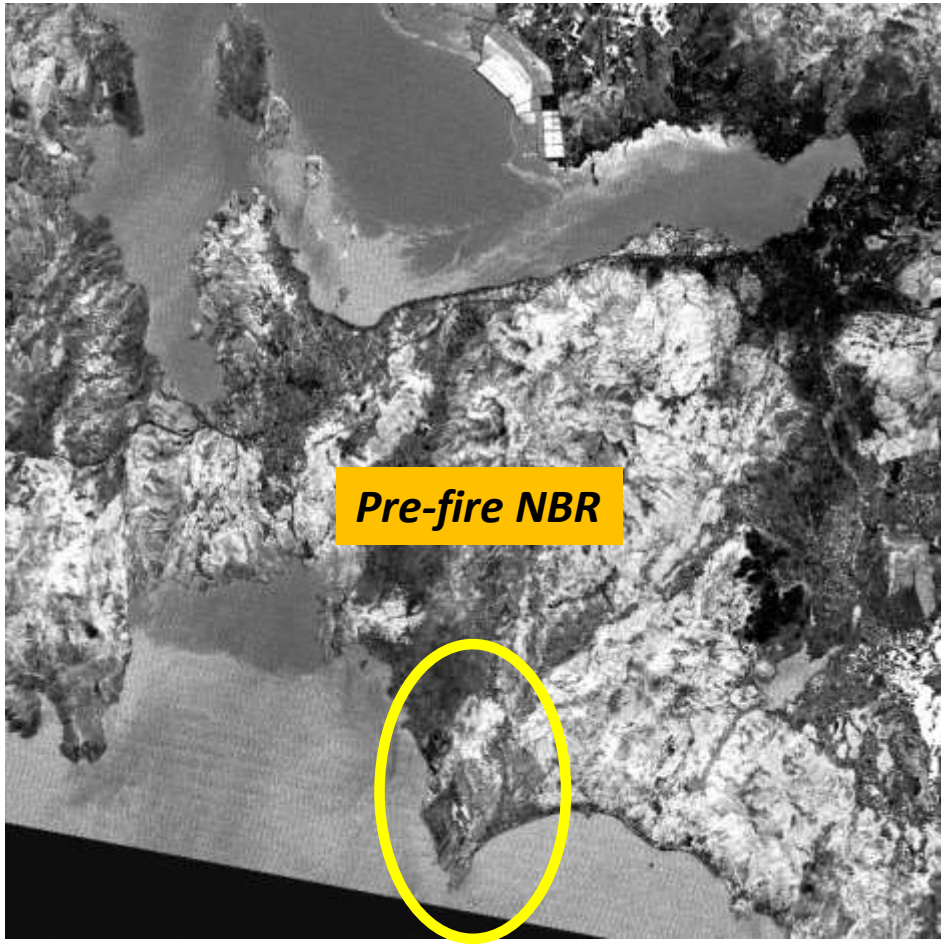

NBR
• dNBR
NDVI
• dNDVI
Pixel based classification
Object based classification

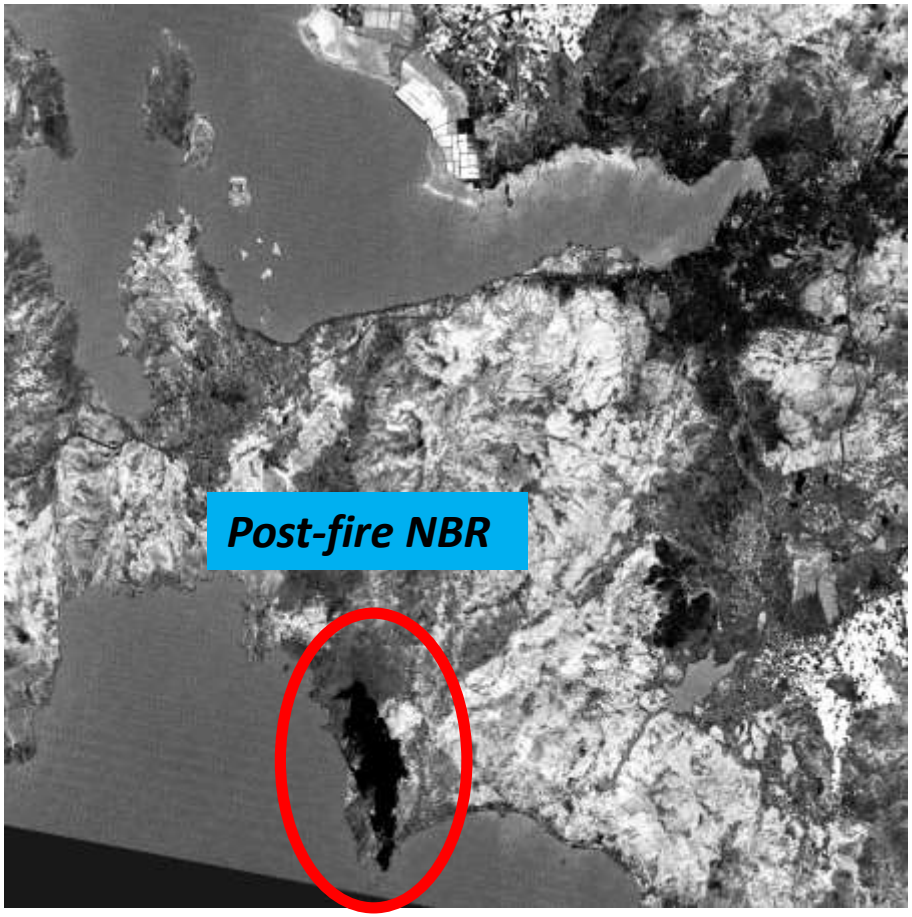
Vegetation/Burn Index
NBR- Normalized Burn Index

- Normalized Burn Index is a commonly index used to detect burned area and some special cases burn severity.
- NBR developed by Key and Benson in 1996 is an algorithm that utilizes the ratio between two reflectance bands (4 and 7) from Landsat 5/7.
- NBR formula is very similar to that of NDVI except it uses the NIR and SWIR band.
- NBR is expressed by mathematical formulas obtained using near-infrared (NIR) and short-wave infrared (SWIR) bands.

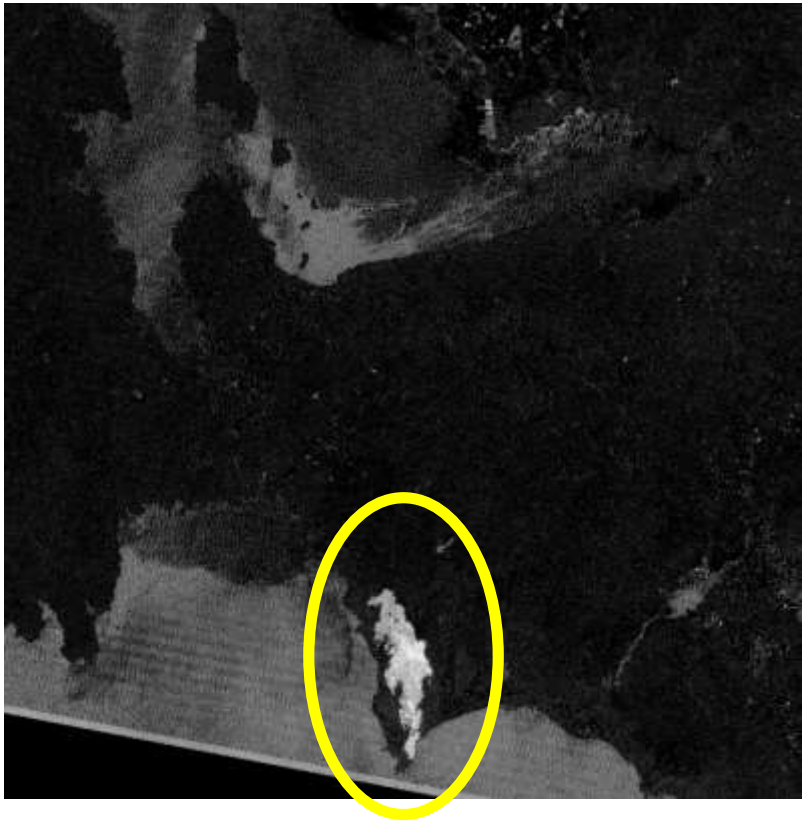
$$NBR = \frac{(NIR - SWIR)}{(NIR + SWIR)}$$

Vegetation/Burn Index
NBR- Normalized Burn Index





(dNBR) Differenced Normalized Burn Index



- NBR is particularly sensitive to the changes in the amount of live green vegetation, moisture content, and some soil conditions which may occur after fire.

- We used the differenced NBR (dNBR) in this study since it has been shown to perform at least as well if not better than other index differencing change detection methods in capturing the spatial complexity of severity within fire perimeters.

- (DNBR) is obtained by subtracting the indices of burned intensity normalized before and after forest fire from each other.
- The difference value which was calculated is 703 ha for the burned areas.

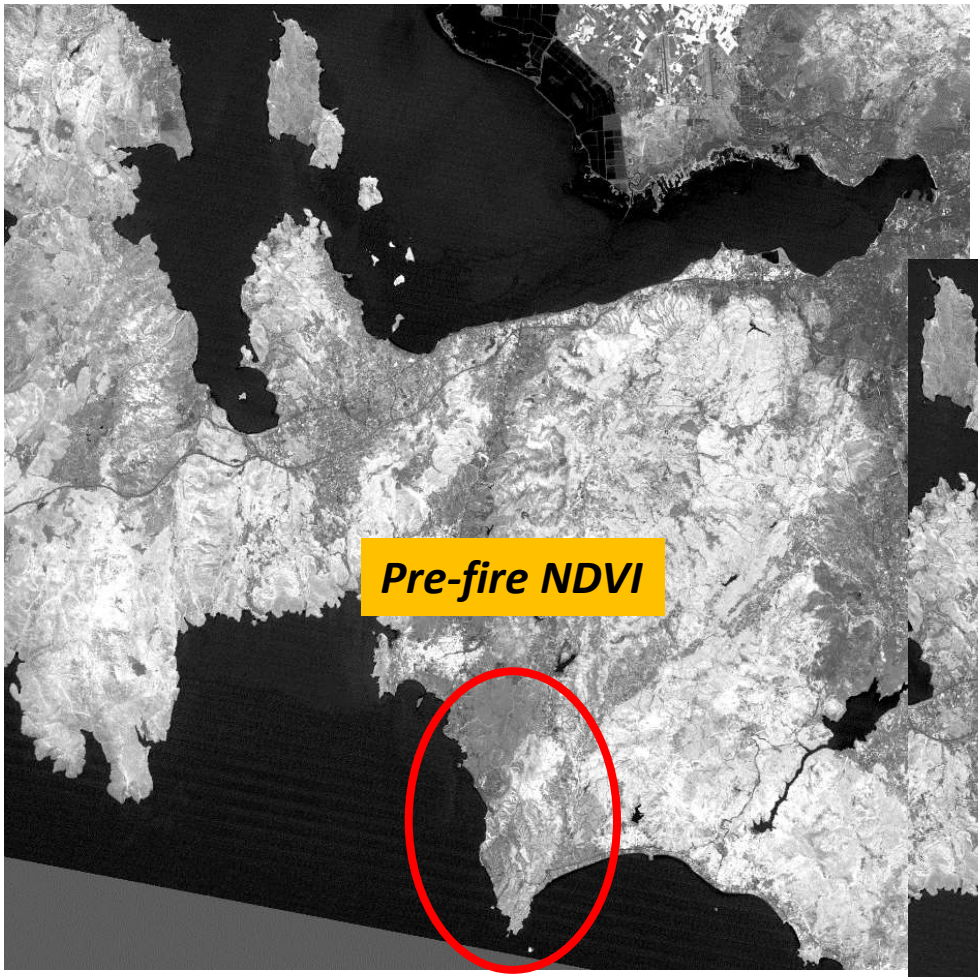
Vegetation/Burn Index
NDVI- Normalized Difference Vegetation Index

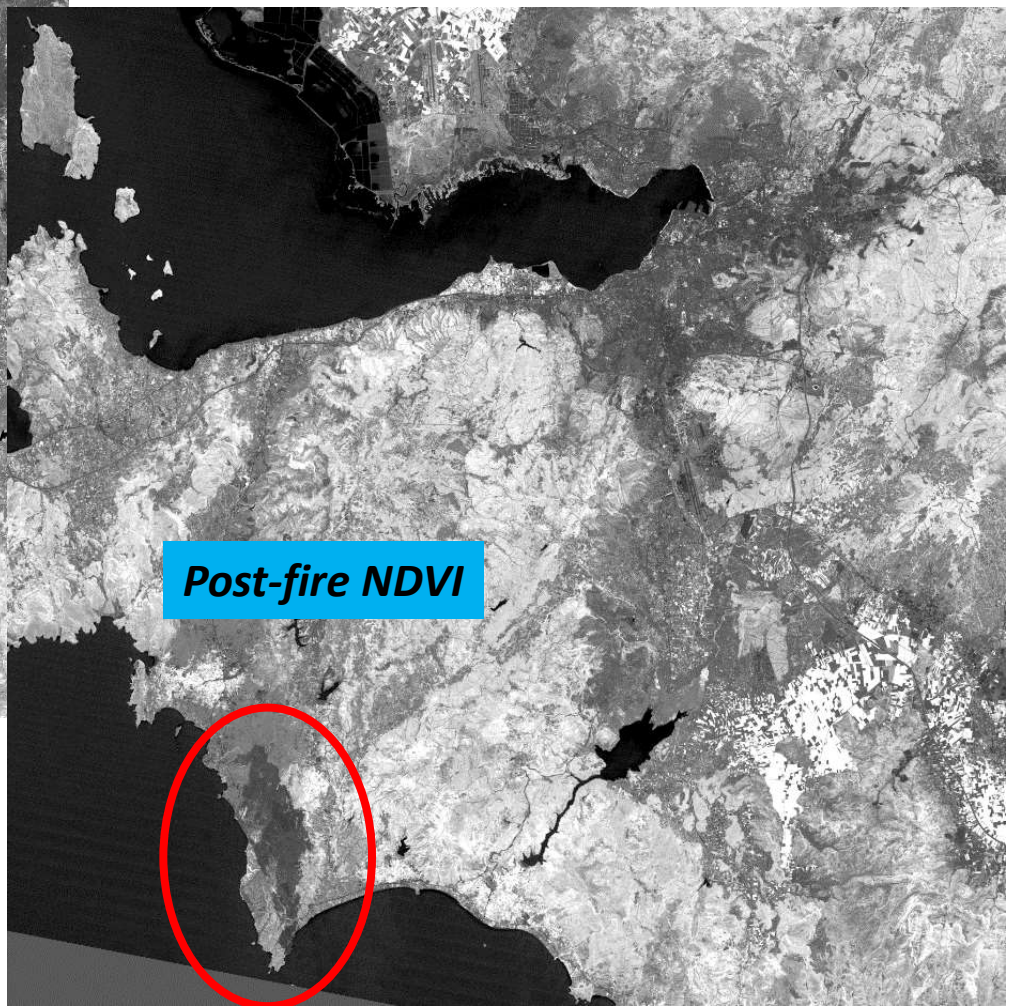
- For creation of risk map and determination of vegetation pattern situation normalized difference vegetation index (NDVI) image was produced.

$$\mathrm{NDVI}=\frac{\boldsymbol{NIR-Red}}{\boldsymbol{NIR+Red}}$$

- In this study, prefire and postfire NDVI were calculated. In prefire image the bright white part indicate that there was a high vegetation. In the postfire image, dark pixel part indicates that there was no or low vegetation.

NDVI- Normalized Difference Vegetation Index



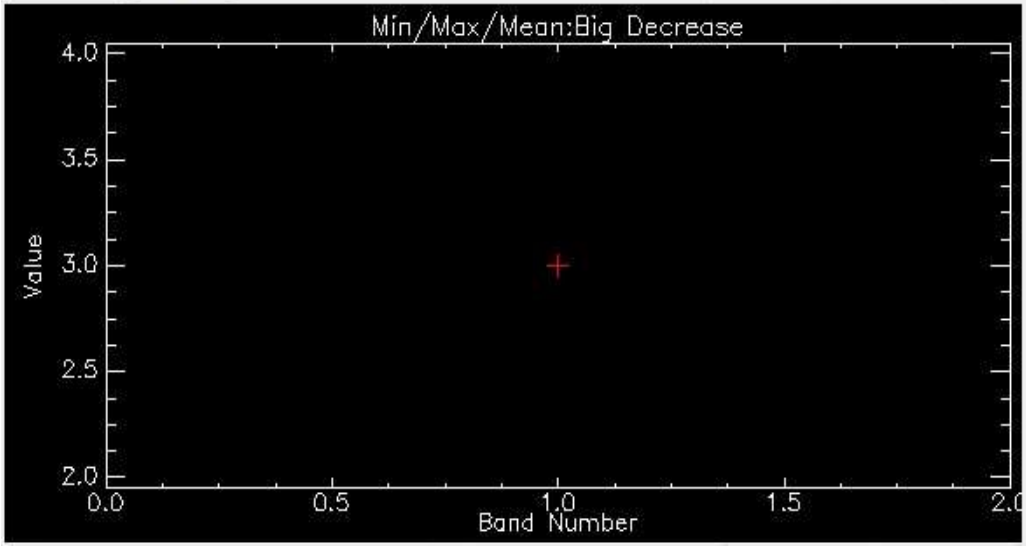


dNDVI

Class Statistics Results: Envi_changedetection_ndvi_diff

File Options

Select Plot | Clear Plot

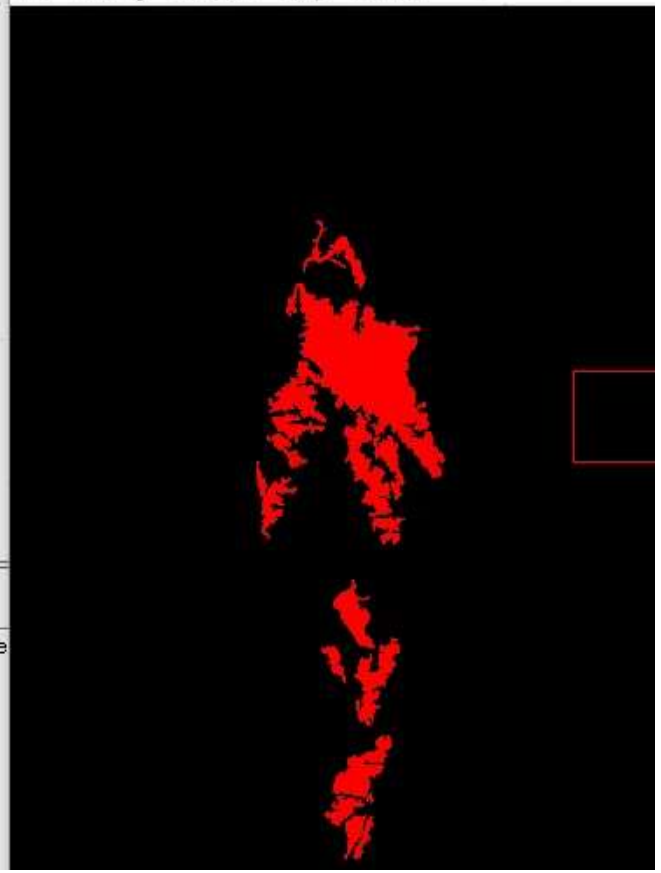


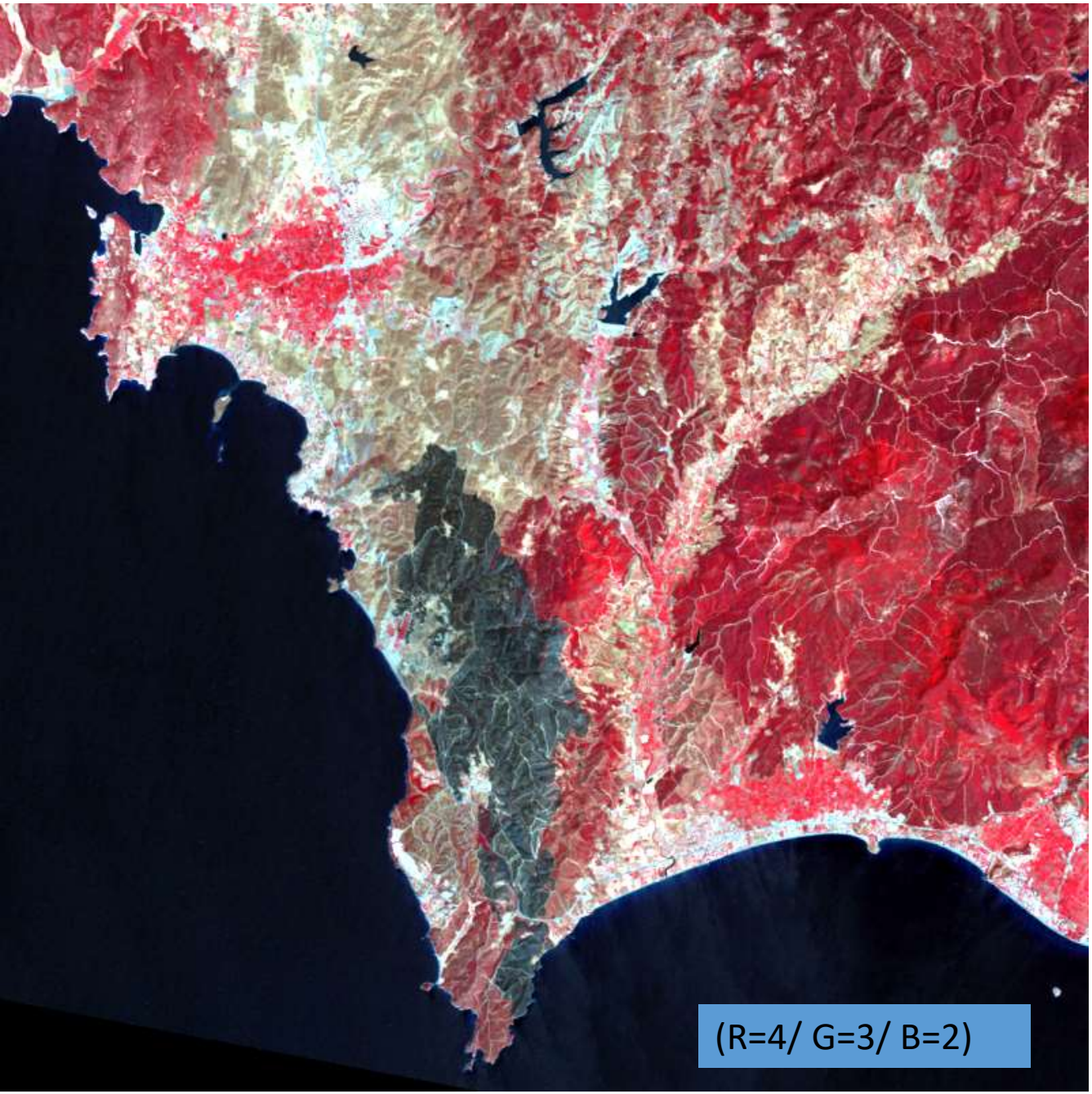
Select Stat

```
Filename: C:\Users\asli_\Documents\PROJELER\seferihisar_orman_yangini\Envi_changede
Dims: Full Scene (3,884,840 points)

Class Distribution Summary
Big Decrease: 7,909 points (0.204%) (711.8100 Hectares)

Stats for Class: Big Decrease
Basic Stats     Min     Max      Mean     Stdev
     Band 1       3       3  3.000000  0.000000
```

#1 Band 1:Envi_changedetection_nd...

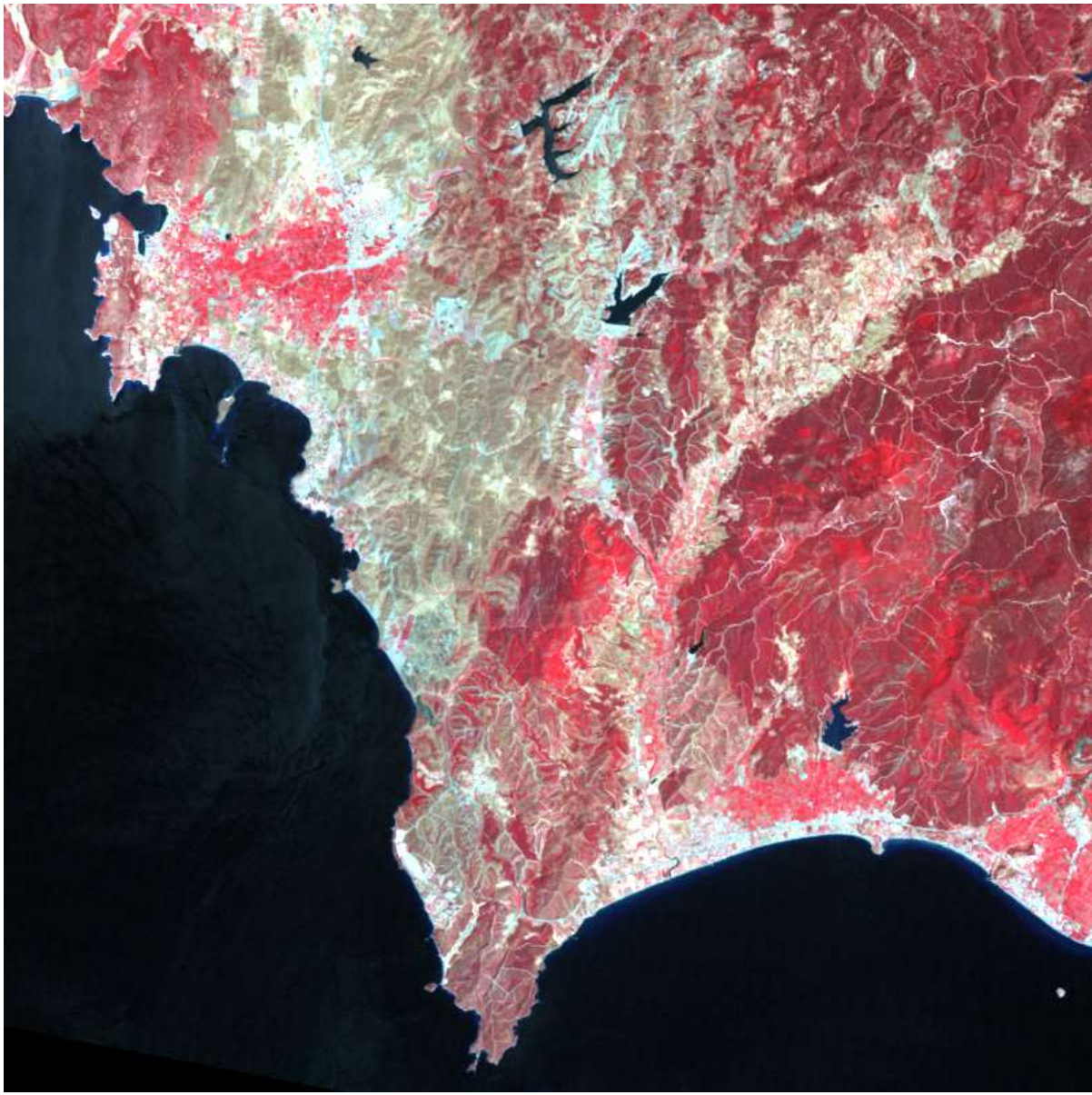
File Overlay Enhance Tools Window



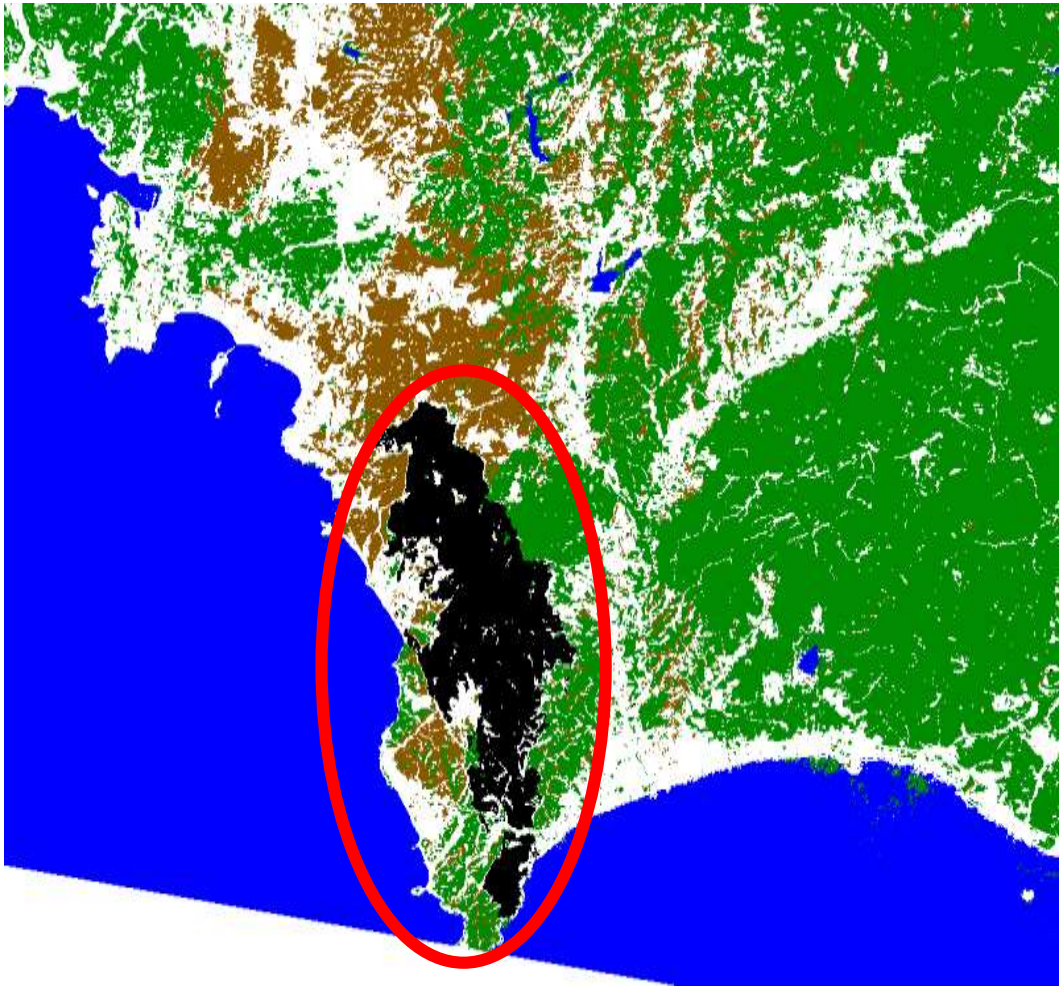


✓In vegetation classification, the unhealthy and burned vegetation seems to be black to grey red in the false color composite image.

- ✓Besides NDVI and NBR indices, supervised classification method was used to classify the image.
- ✓For pre and post fire images, false color composition using 432 (RGB) bands of Landsat was used.
- ✓In vegetation classification, the healthy vegetation reflects or radiates the infrared light strongly and it seems to be bright red in the false color composite image.

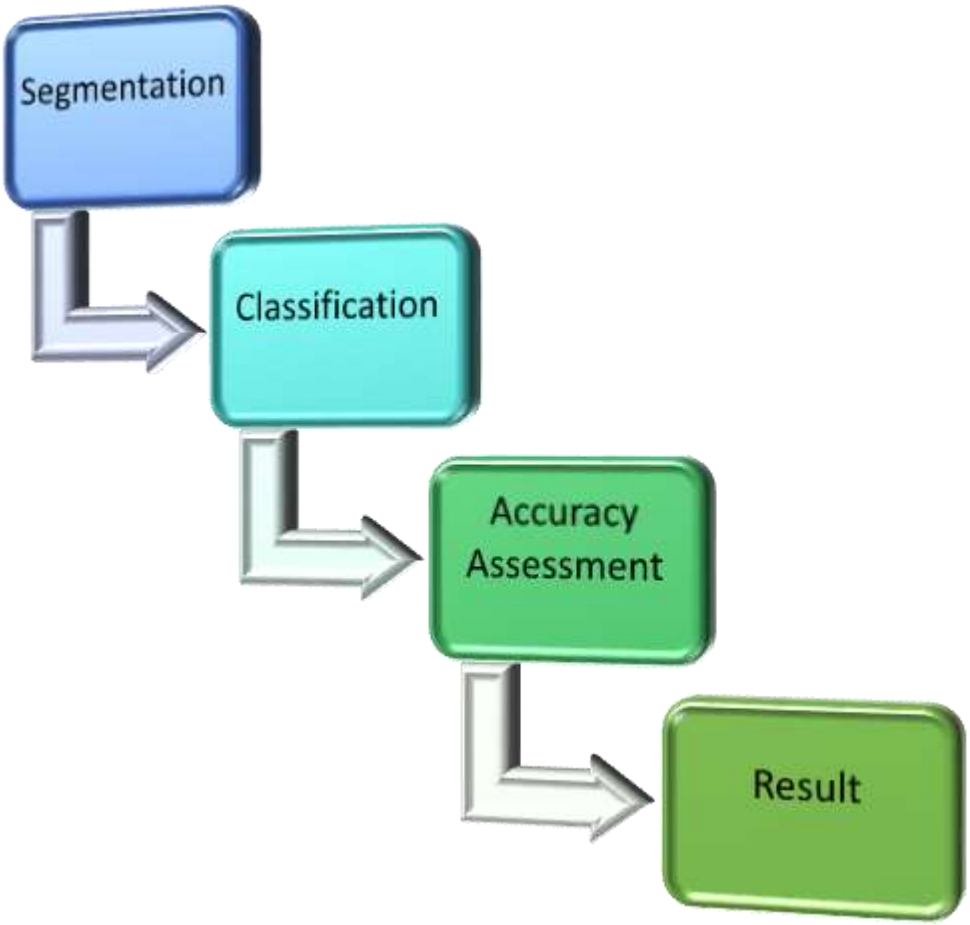


Pixel based image analysis

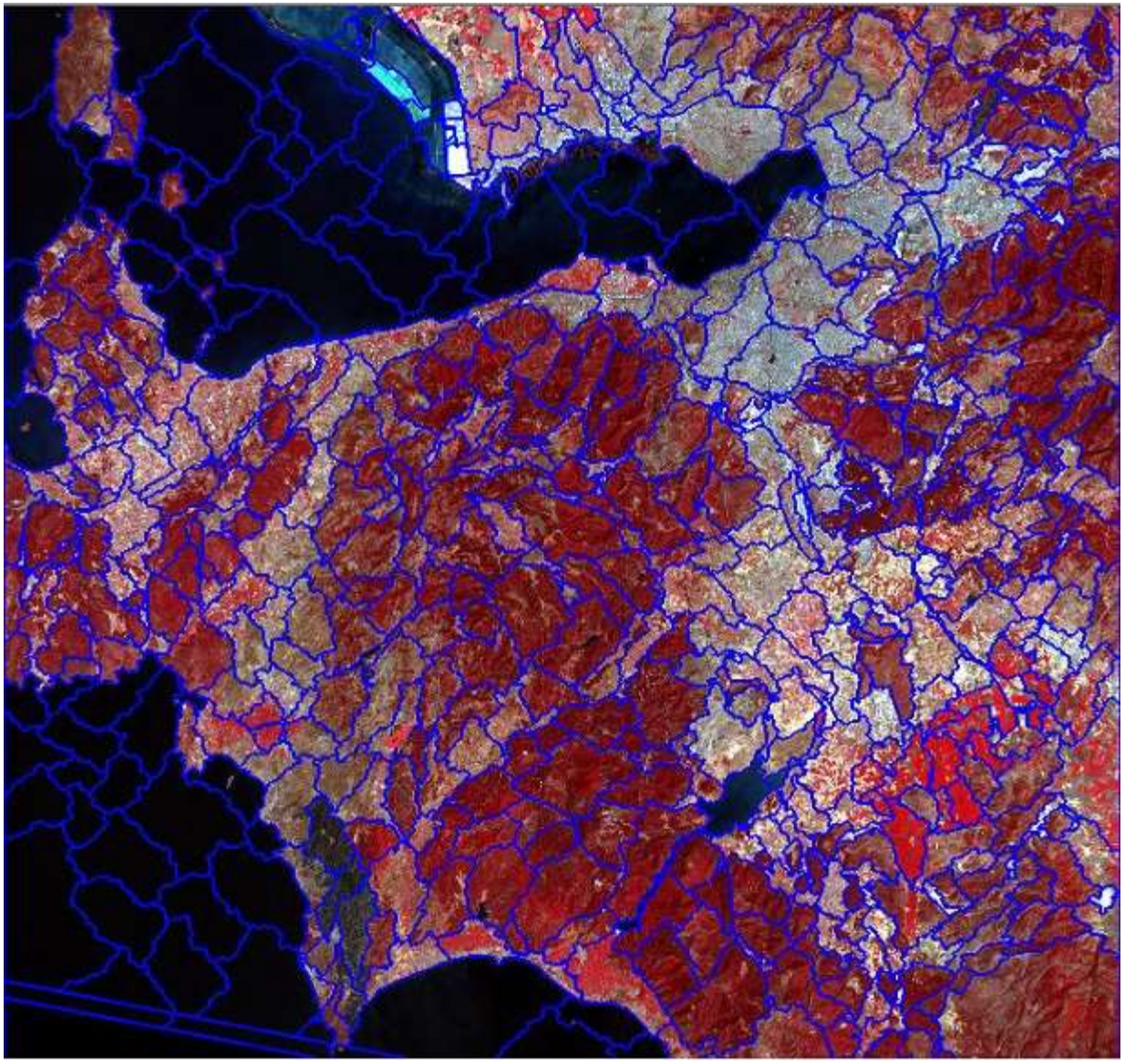


- Pixel based image classification is an analysis intented to make clusters and classes in a multi dimensional spectral space, using image pixels of multispectral satellite imagery.
- Post-fire satellite image was classified by maximum likelihood algorithm.
- 5 main classes were produced (sea/lake, burned area, vegetation, urban and soil).
- The calculation after the classification is 699 ha. For the burned areas.

Object based image analysis



Segmentation

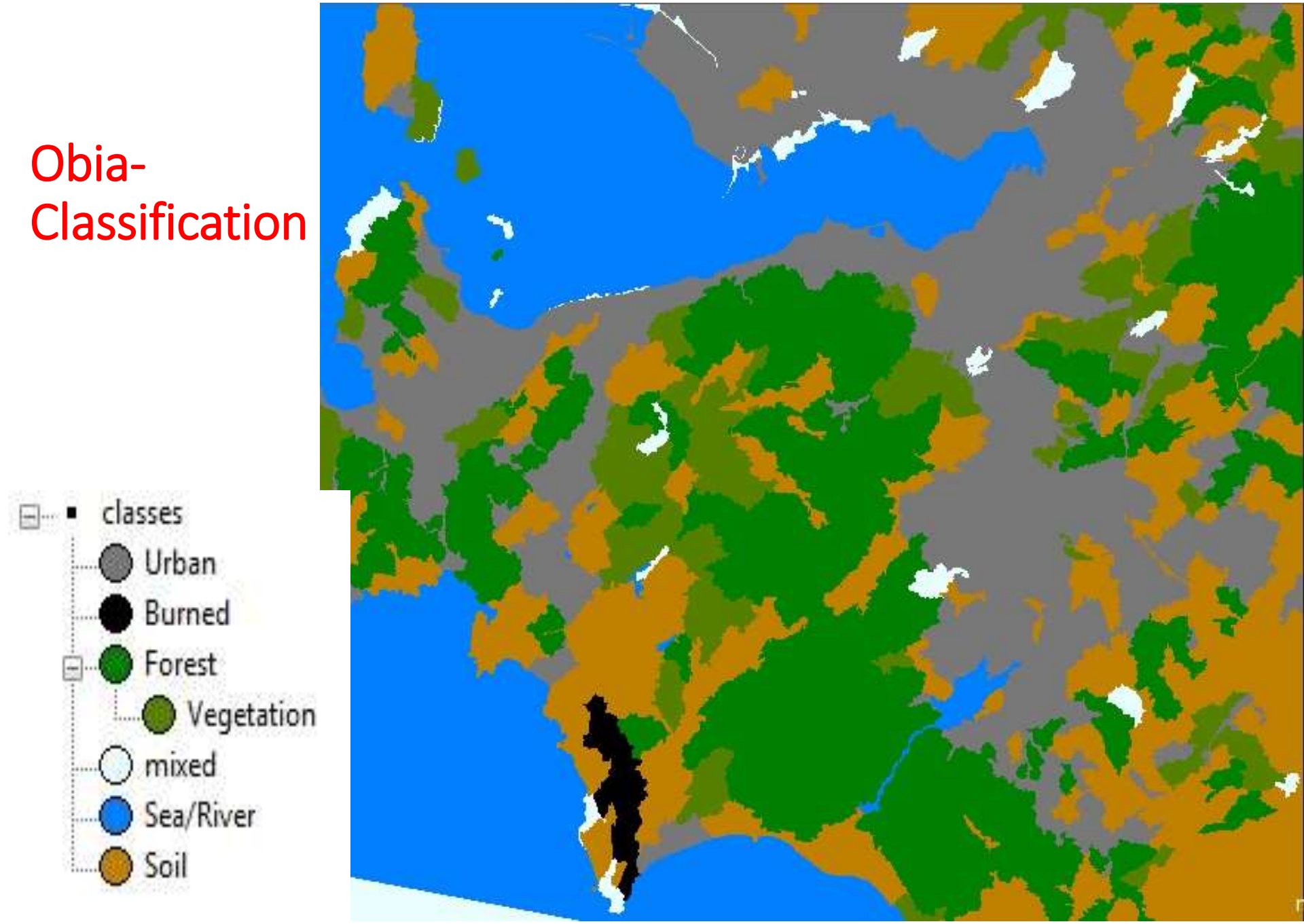


In the first phase of OBIA application, ***multi-resolution segmentation*** was applied.

The most convenient parameters (such as scale, color, shape, smoothness and compactness) were chosen to obtain the objects in case study area.

Scale	Shape	Compactness
80	0.5	0.4

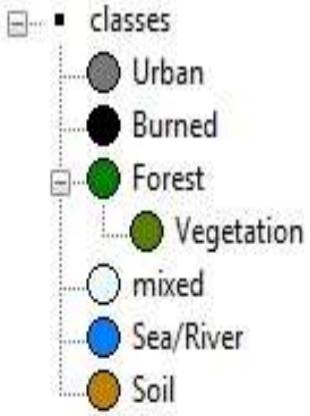
Obia-Classification



Obia-Accuracy Assessment

Obia-Classification

The calculation after the classification is 714 ha. for the burned areas.



Results & Discussion

- According to results of this study, analysis of remotely sensed data provided valuable information for determination of the damaged areas after the forest fire occurred in Seferihisar District.
- Different methods were applied to analyze pre-and post- fire Landsat 5 satellite imagery in order to detect the burnt and affected areas.
- Spatial distribution of burnt and affected areas showed a strong relation with NBR data NDVI data and ground truth information.
- Integrated usage of remotely sensed data and ground truth information give valuable information about spatial distribution and areal extends of the fire damages.

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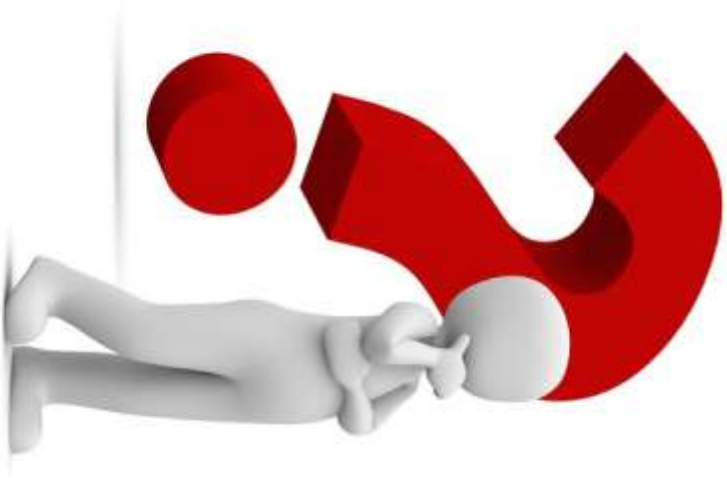
QUESTIONS ?



Thank you for your interest