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
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• Results
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.
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**
- **Campfires**
- **Fireworks**
- **Car accidents**
Natural causes account for about 10% of all wildfires.

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

Hot magma in the earth's 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 erosion
- 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.

<table>
<thead>
<tr>
<th>Year</th>
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<th>Burnt Area (ha)</th>
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<td>2016</td>
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</table>
700 hectares forest lands burned

Seferihisar forest fire 10/08/2009
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 km². Seferihisar is located in the Mediterranean macroclimate in terms of climate characteristics and has an average temperature of 17 °C, with an average temperature of 8 °C in January and 27 °C in July.
### Datasets

<table>
<thead>
<tr>
<th>Satellites</th>
<th>Acquisition Date</th>
<th>Spatial Resolution</th>
<th>Sensor</th>
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<td>30 m</td>
<td>L5</td>
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<tr>
<td>Landsat 5</td>
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<td>30 m</td>
<td>L5</td>
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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.

\[
NBR = \frac{(\text{NIR} - \text{SWIR})}{(\text{NIR} + \text{SWIR})}
\]
Vegetation/Burn Index
NBR- Normalized Burn Index

Pre-fire NBR

Post-fire NBR
(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.

\[
\text{NDVI} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}
\]

• 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

Pre-fire NDVI

Post-fire NDVI
dNDVI

Filename: C:\Users\asli\Documents\PROJELEN\seferihisar_orman_yangini\Envi_changedetection\Envi_changede
Dims: Full Scene (3,884,840 points)
Class Distribution Summary
Big Decrease: 7,909 points (0.20%) (711.8100 Hectares)
Stats for Class: Big Decrease
Basic Stats Min Max Mean Stdev
Band 1 3 3 3.000000 0.000000
✓ In vegetation classification, the unhealthy and burned vegetation seems to be black to grey red in the false color composite image.

(R=4/ G=3/ B=2)
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 classification is an analysis intended 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

1. Segmentation
2. Classification
3. Accuracy Assessment
4. Result
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.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Shape</th>
<th>Compactness</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>0.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>
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.
• http://www.ntv.com.tr/galeri/turkiye/izmirde-orman-yangini,64XrxyFkJKGDpFdhHbc-EsQ/-ebKu3-J-0O0tkknnZqPiQ
• Picotte, J.J., Robertson, K.M., (2009), Accuracy of remote sensing wildland fire-burned area in Southeastern U.S. Coastal Plain Habitats.
QUESTIONS?
Thank you for your interest