WILDFIRE SPREADING ACROSS THE URBAN AREA: DEFINITION AND MAPPING OF VEGETATION CONNECTIVITY

EGU General Assembly 2020

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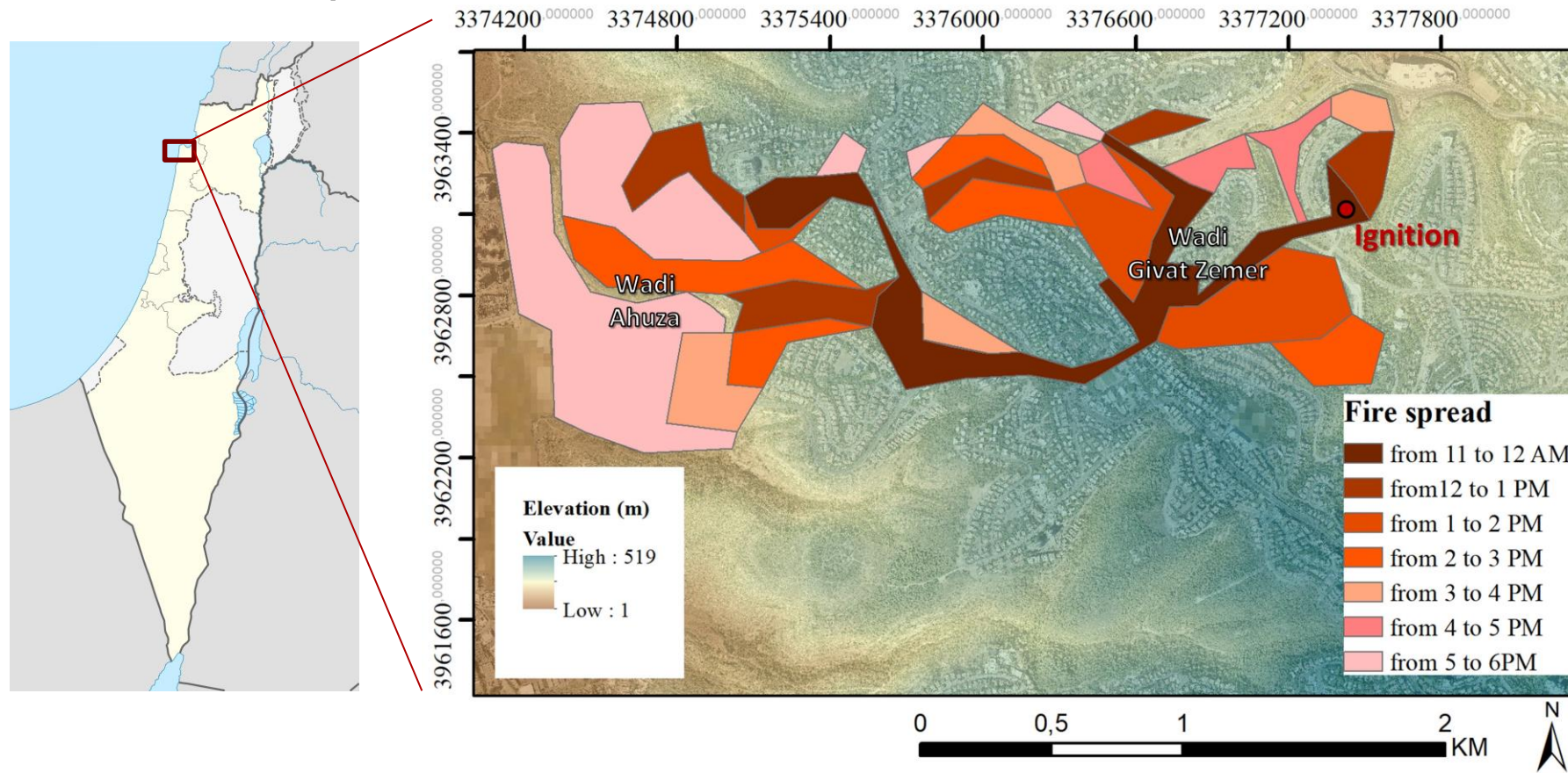
Urban wildfires

The proximity of a wildfire to urban areas multiplies the potential fire hazard. Simultaneously, anthropogenic activity near or directly on the natural landscape increases the risk of the fire.

Currently, these areas are managed in the Wildland-Urban Interface (WUI) concept framework. WUI declares the non-flammability of the cities due to insignificant amount of fuel in these territoriesю The special land-use regime near cities, forming buffer zones, and compact urban planning were convenient approaches to reduce fire hazards in WUI.
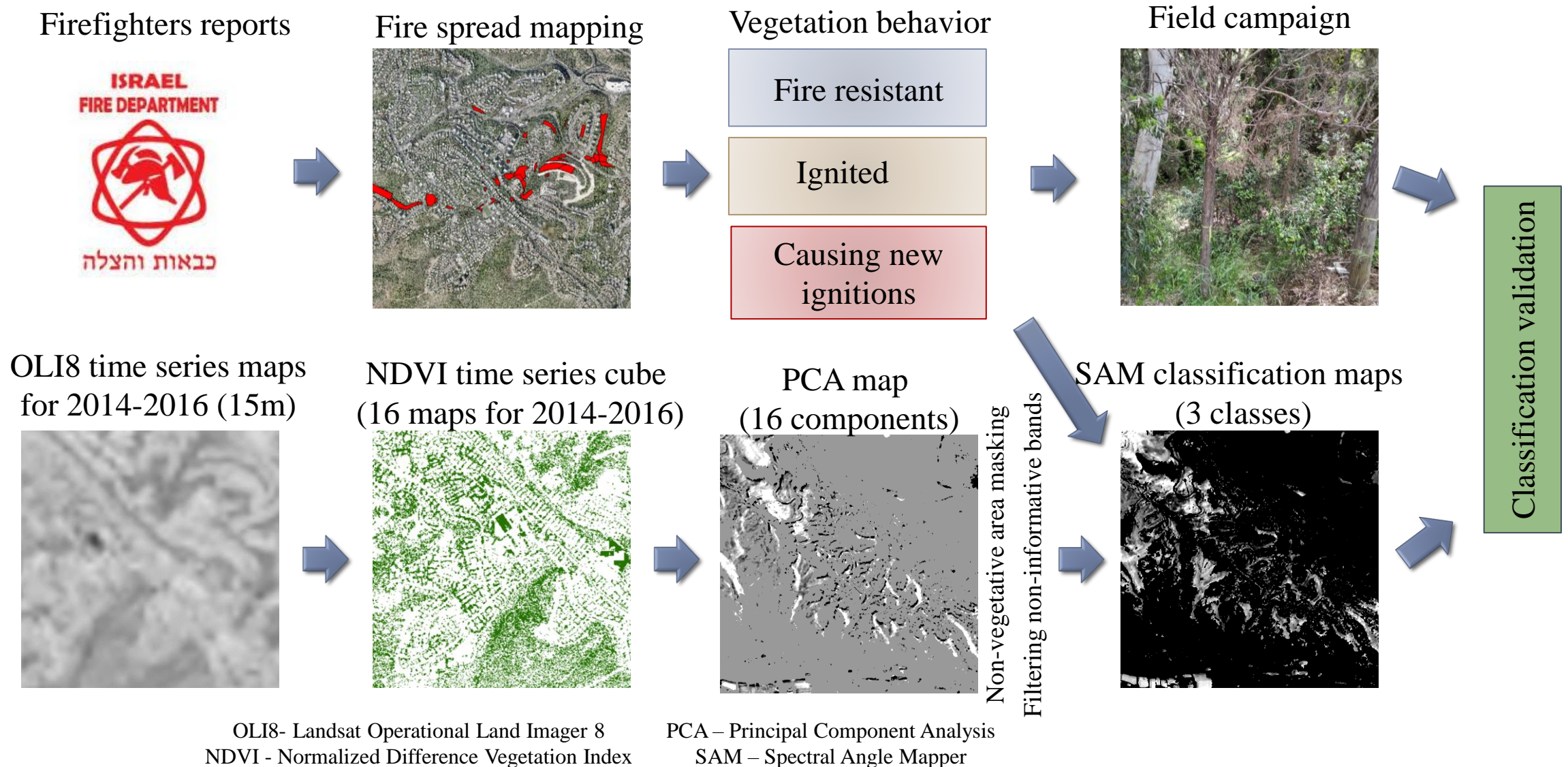

Nevertheless, experience has proven the ineffectiveness of the fire-resistant city approach: wildfires not only penetrate the city, but also cross it using urban vegetation as fuel: Greece (Athens 2009&2015, Thasos 2016, Mati 2018), France (Marseilles 2009&2016), Spain (Javea 2012&2016) etc.

Case study: wildfire on November 24, 2016 in Haifa (Mount Carmel), Israel

Vegetation composition: trees (Pinus halepensis, Quercus spp., Pistacia spp.), perennial shrubs, grass and urban planting
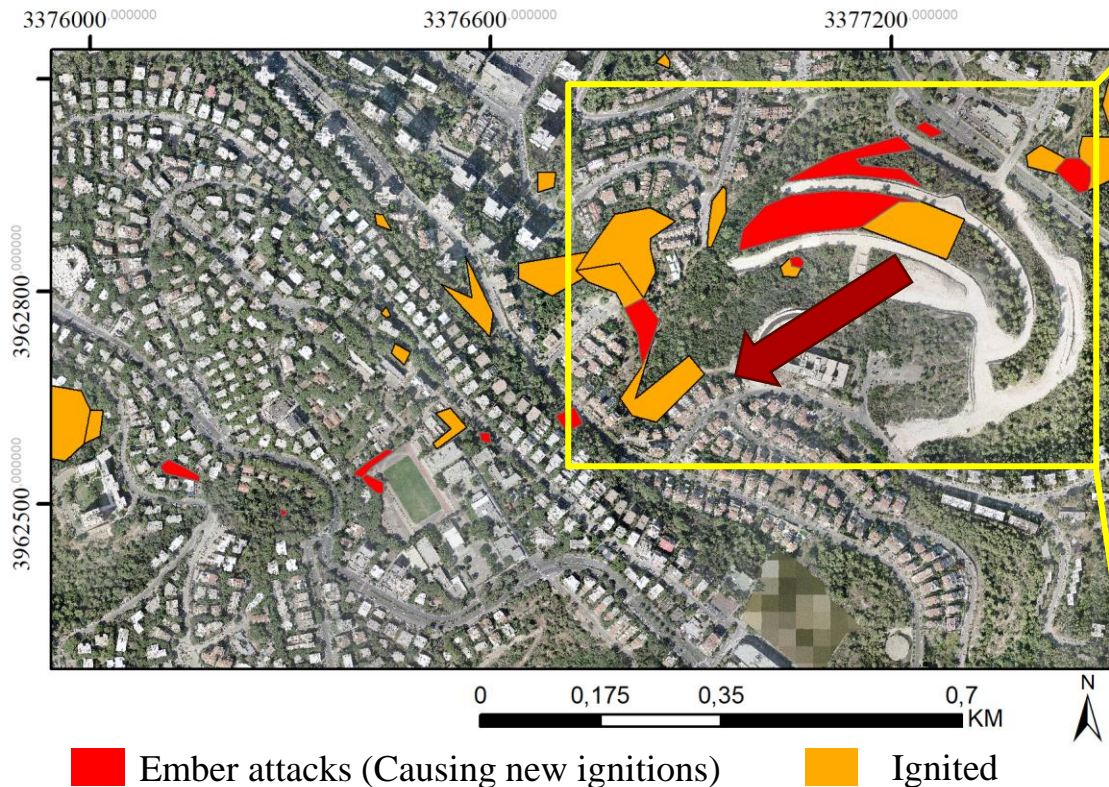
Haifa's wildfire lasted nearly twenty-four hours despite all efforts. The fire fighting was complicated due to strong dry winds that supported rapid fire spread. To ensure safety, sixty thousand people were evacuated from the fire risk zone. According to the initial assessment, 13 ha was burned, and the total damage amounted to €100 million.

Methodology

Firefighters reports

Fire spread mapping

Vegetation behavior

Fire resistant

Ignited

Causing new ignitions

Field campaign

Classification validation

OLI8 time series maps for 2014-2016 (15m)

NDVI time series cube (16 maps for 2014-2016)

PCA map (16 components)

Non-vegetative area masking
Filtering non-informative bands

SAM classification maps (3 classes)

OLI8- Landsat Operational Land Imager 8
NDVI - Normalized Difference Vegetation Index

PCA – Principal Component Analysis
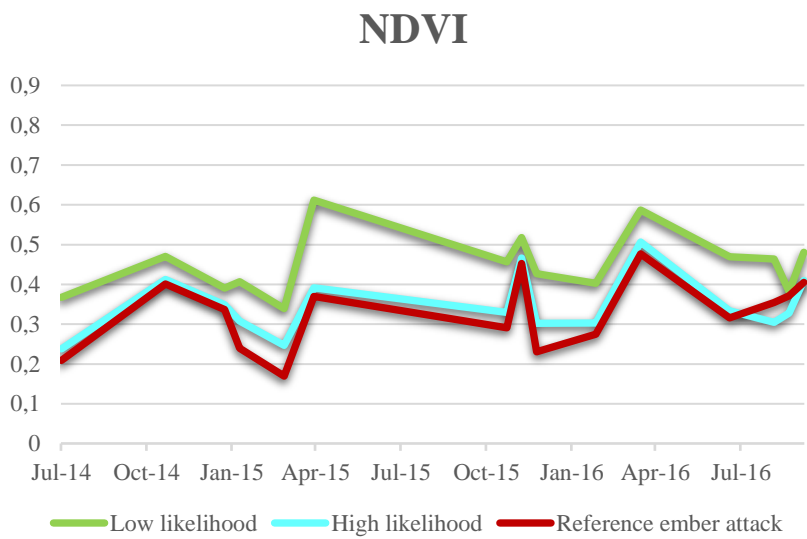SAM – Spectral Angle Mapper
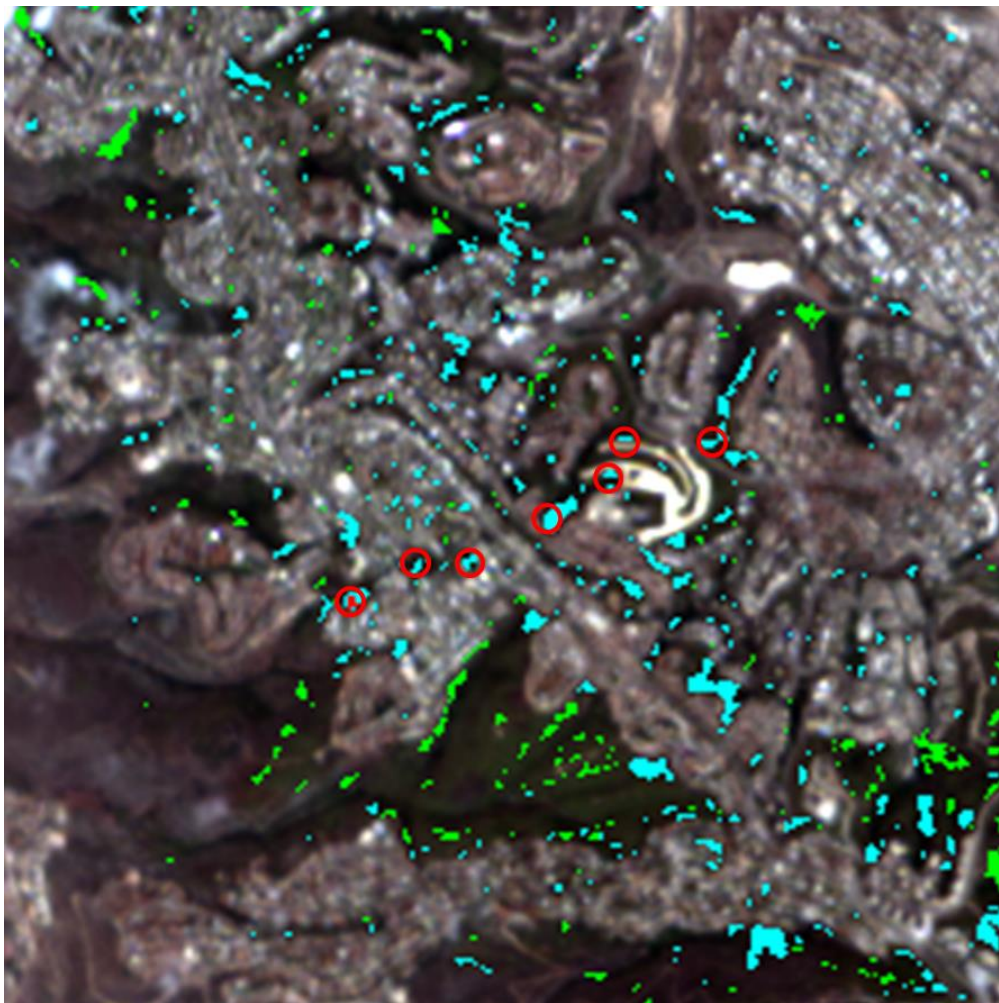
ISRAEL FIRE DEPARTMENT
כבאות והצלה

# Results: fire behavior patterns and role of vegetation

1. The fire was mainly affected by local wind and effects produced by complex topography and buildings.
2. The fire movement along the slope in contrast to the wind direction was caused by a relatively large ignited vegetation area.
3. The main propagation strategy at the beginning of the event was ember attacks, while in the last hours the fire mainly propagates on the dense vegetation regardless of other parameters

Wind effect

Slope

Pines

Slope

Wind effect

Ember attacks (pines)

Ignition point

■ Ember attacks (Causing new ignitions)   ■ Ignited

Results: 'Ember attacks' SAM classification

NDVI

Legend: Low likelihood — High likelihood — Reference ember attack

The main difference between 'ember attacks' from other vegetation is low NDVI. This effect is especially noticeable in the winter. Most of the estimated high likelihood areas are adjacent to built-up environment
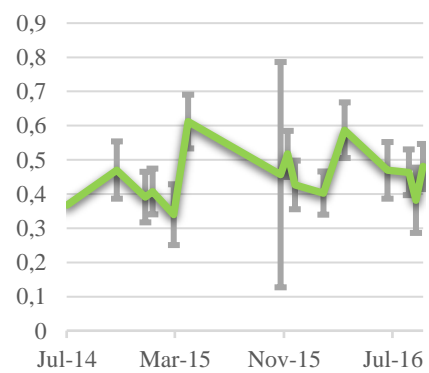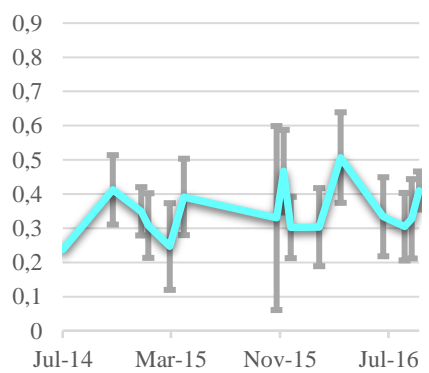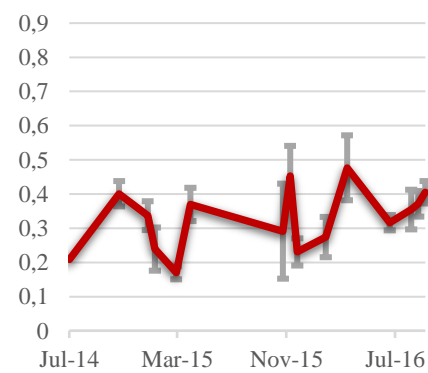
High likelihood   Low likelihood   O Actual ember attacks

Reference ember attack   High likelihood   Low likelihood

Validation: field campaign in winter 2019/2020

Medium likelihood patches

The examined patches represent composition of deciduous and coniferous trees (Pinus halepensis, Pistacia spp and Ceratōnia Silīqua) mixed with densely grown shrubs.

High likelihood patches

The surveyed areas were standing alone trees (mainly coniferous - Pinus halepensis) surrounded by timber litter and scarce young shoots of shrubs.

Low likelihood patches

The most part of estimated area lays out of the built-up environment and presents itself shrubs and sparse stunted trees growing on the slopes of the mount Carmel. Inside the city, there were observed trees (*Punica, Nérium),* bushes and urban green planting

Conclusion

- Urban areas are sensitive to wildfire because of connectivity: fire moves from one green patch to another, bypassing nonflammable structures

- Wildfire spreads in the urban area through ember attacks

- The **fire vegetation connectivity** in urban areas can be defined by fuel ability to ignite and reproduce new embers

- NDVI time series map allow to detect urban vegetation areas most likely to produce ember attacks in case of wildfire

Thank you for your attention!

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